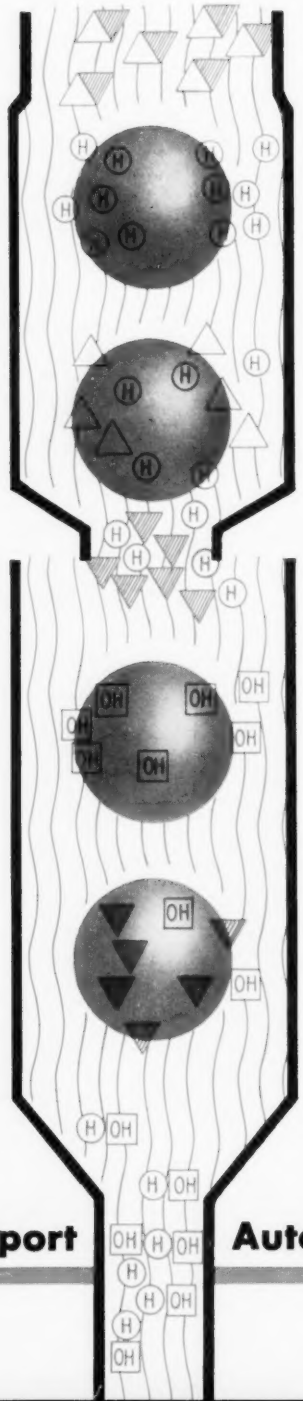
For engineers who design and manage the power and plant services

Power

FEBRUARY 1958
ONE DOLLAR
A McGRAW-HILL PUBLICATION



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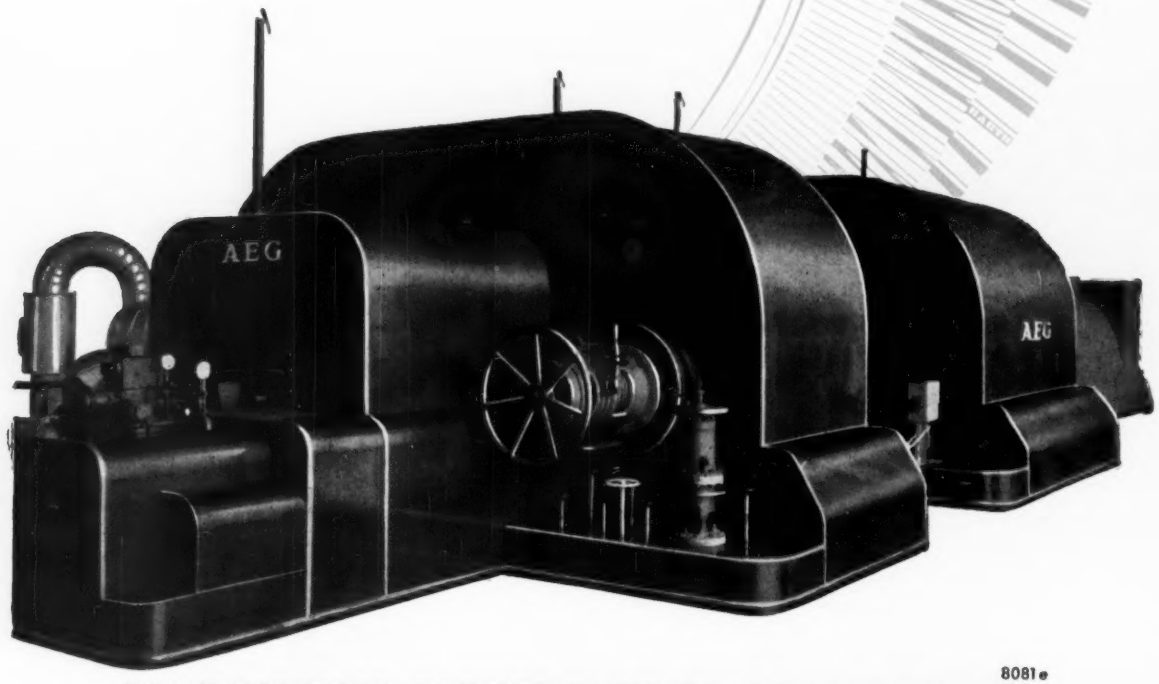
a *TD* report **Automatic demineralizing takes upswing ▸ 71**

AEG

TURBINE-GENERATOR SETS

In 50 years AEG supplied over 5,000 turbine-generator sets up to the largest units with an total output of 25 million kW. AEG's engineering during half a century has contributed to economical power generation and thus for a higher living standard.
AEG are known the world over as pioneers for technical and economic progress.



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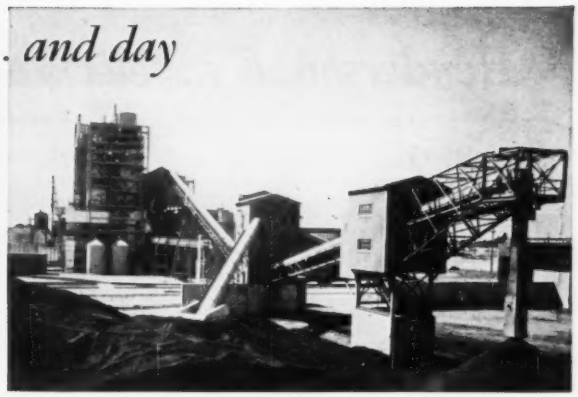


LINK-BELT coal-carrying conveyors prove

sure route to dependable power

TWO 24-IN. WIDE BELT CONVEYORS, carrying coal over bunkers at Utah Power and Light Company's Gadsby Station, are part of network of conveyors totalling over 1100 ft. in length. Motor-propelled belt conveyor trippers (shown) distribute coal evenly to bunkers. This $38-million power plant also burns natural gas and petroleum pitch.

Coal handling system at Utah Power and Light Co. can move 400 tph . . . has 100,000-ton storage capacity

GADSBY Station in Salt Lake City is one of the major power plants in the West that burns coal as an alternate fuel. Its two coal-burning boilers consume 1700 tons a day under full load. And to make sure the boilers always have an adequate and ready supply of fuel, this 241,000-kilowatt plant utilizes an efficiently integrated Link-Belt coal handling system.

Working with the Bechtel Corporation, consulting engineers, Link-Belt furnished the system to handle coal smoothly and at low per-ton cost—from railroad cars to crusher . . . to and from storage . . . to bunkers.

Whether your coal handling problems involve unloading, storing, weighing, reclaiming, elevating or feeding—Link-Belt's vast experience and complete line of equipment can work for you. Get complete details from your nearest Link-Belt office. Or write for Book 2410, containing the latest layouts and equipment for power plants, large and small.

14,708

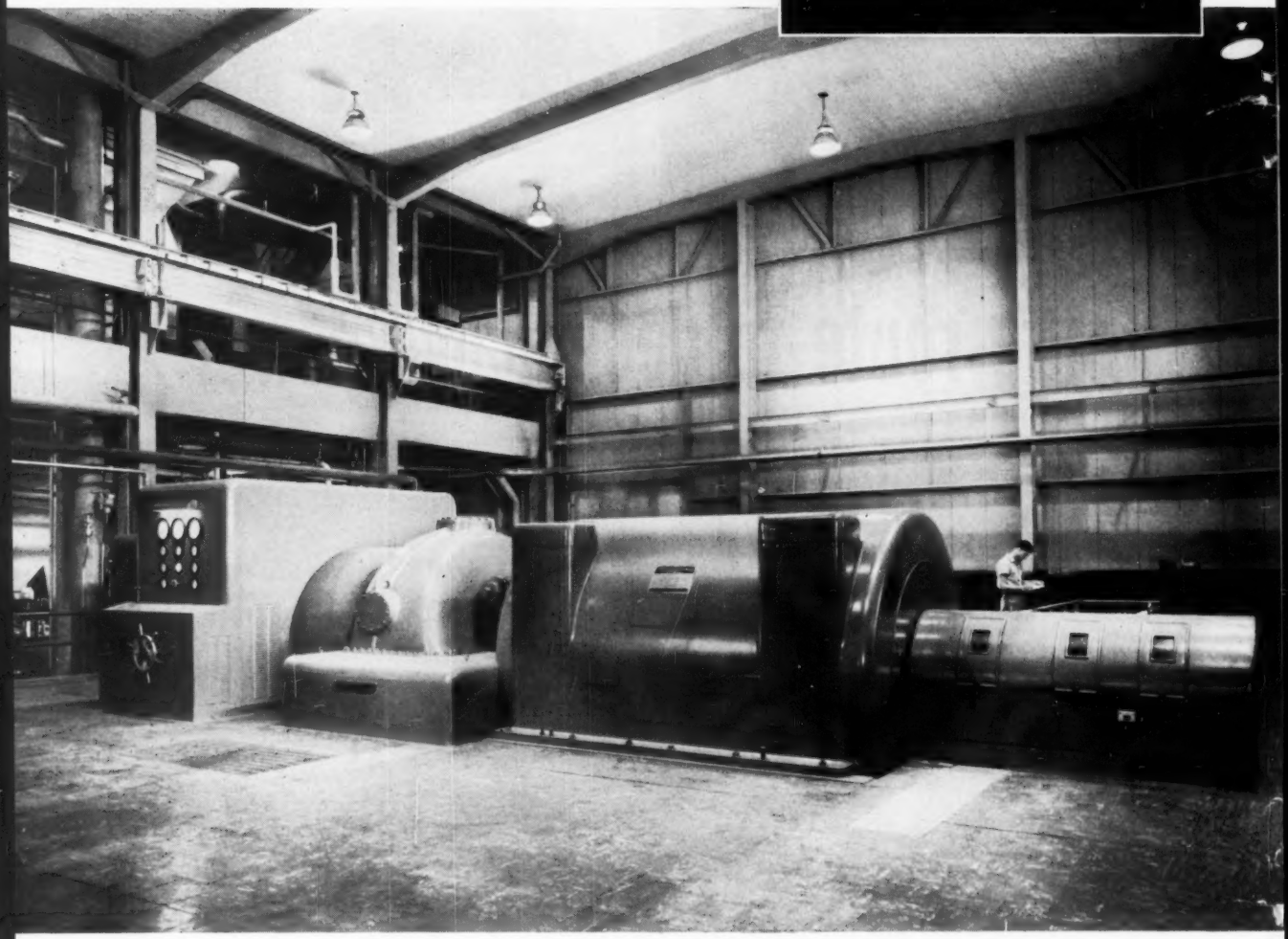
LINK-BELT

COAL HANDLING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.

Henderson, Ky., selects a third

DE LAVAL
TURBINE GENERATOR



In 1950,...

two De Laval 5,000 kw multi-stage turbine generators were installed in the central station of Henderson, Kentucky. These units operated so dependably that the City of Henderson ordered a new, larger De Laval turbine generator to meet their increased power requirements.

Put on the line in 1956,...

this 12,650 kw De Laval machine is an AIEE-ASME Preferred Standard Unit. It operates at 600 psig and 825F; the turbine speed is 3,600 rpm.

De Laval multi-stage turbines are rugged in construction, economical to run. Transmission of power may be either direct or through speed reducing gears. De Laval multi-stage steam turbines are available for all services, including operation at the high pressures, high temperatures employed in steam plants of the latest design. Units are built in sizes up to 25,000 hp.

DE LAVAL *Turbine Generators*

DE LAVAL STEAM TURBINE COMPANY
815 Nottingham Way, Trenton 2, New Jersey

DL-390

In Power this month

FEBRUARY 1958 • VOL. 102 • NO. 2 • 76TH YEAR

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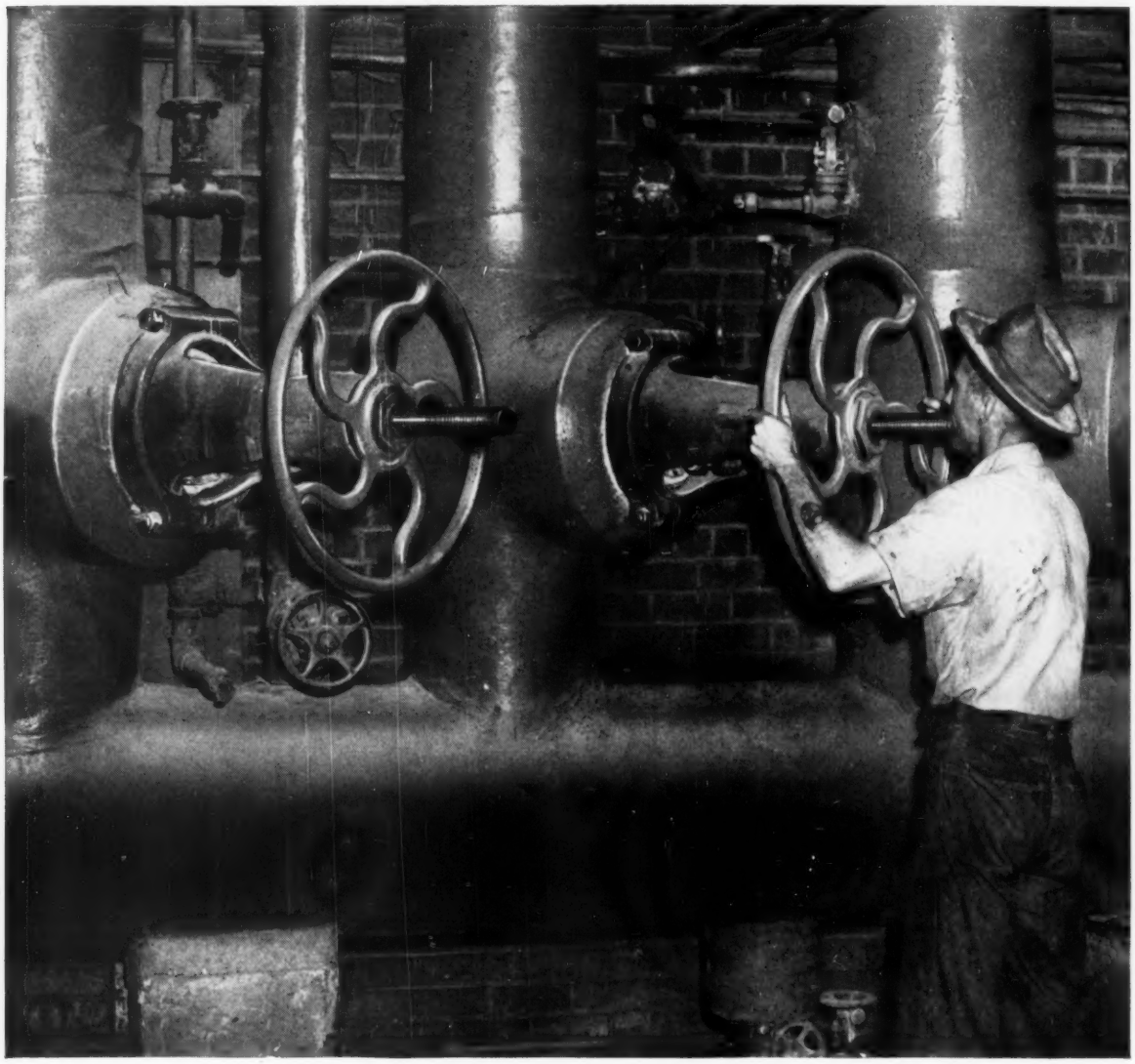
No Bonnet-Joint Maintenance—No Bonnet-Joint Leakage



These valves helped the maintenance crew win a losing battle

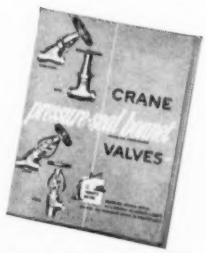
This process industry plant saw the danger signal. Servicing leaky valve bonnet joints was taking too much time. Other important maintenance work was being neglected.

That's why, in 1947, when expanding the power plant, Crane Pressure-Seal Bonnet Gates were chosen for main steam service as shown above. Working pressure: 600 psi at 725 deg. F.

These Crane valves need no bonnet joint maintenance. The joint is leakproof—sealed tight by internal fluid pressure. Crane alloy seats and flexible wedge disc make closure tight and easy.

To date, the Crane Pressure-Seal Gates have given this plant over 9 years' uninterrupted service. The maintenance crew hasn't touched them except for routine care.

Full information on these modern power service valves is given in Circular AD-1936. Get a copy from your Crane Representative or by writing to address below.



Ask for Circular AD-1936

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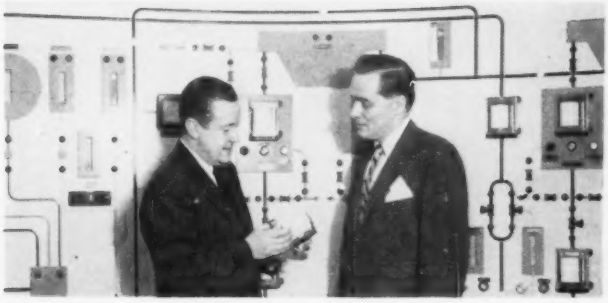

SMITH AND MARKS: Probing for *TD* trends in water demineralization

Ten years ago last December, POWER published its 65th special report. The subject: *Fundamentals of water treatment.* As indicated in that early report, results in many installations vouched for the water-demineralizing process as a "practical, economical method of producing water virtually free of electrolytes. Demineralizing cost compares favorably with that of evaporation, which usually runs from $2 to $6 per 1000 gal for single effect evaporators and $0.50 to $1.25 per 1000 gal for quadruple-effect units."

Changes in demineralizing materials and application techniques during the past decade have been significant. To get a present and future picture, Assistant Editor Bob Marks probed widely for the info published in this month's Today's Development *(TD)* report. Having earned a solid engineering background in the field, Bob knew the people and products that were contributing to the fast-changing picture. One stop he made was at Public Service of New Jersey's Linden Station. Here, while touring the plant with PS's water expert Bob Smith (above photo, left), Marks gathered data for a case-in-point in this issue.

Designing a chart showing what branded demineralizing materials are available, who supplies them, how they are grouped by chemical composition, proved most interesting. For Bob Mark's thoroughly practical, yet unique approach, see pp 72-73.

Lou Lowley

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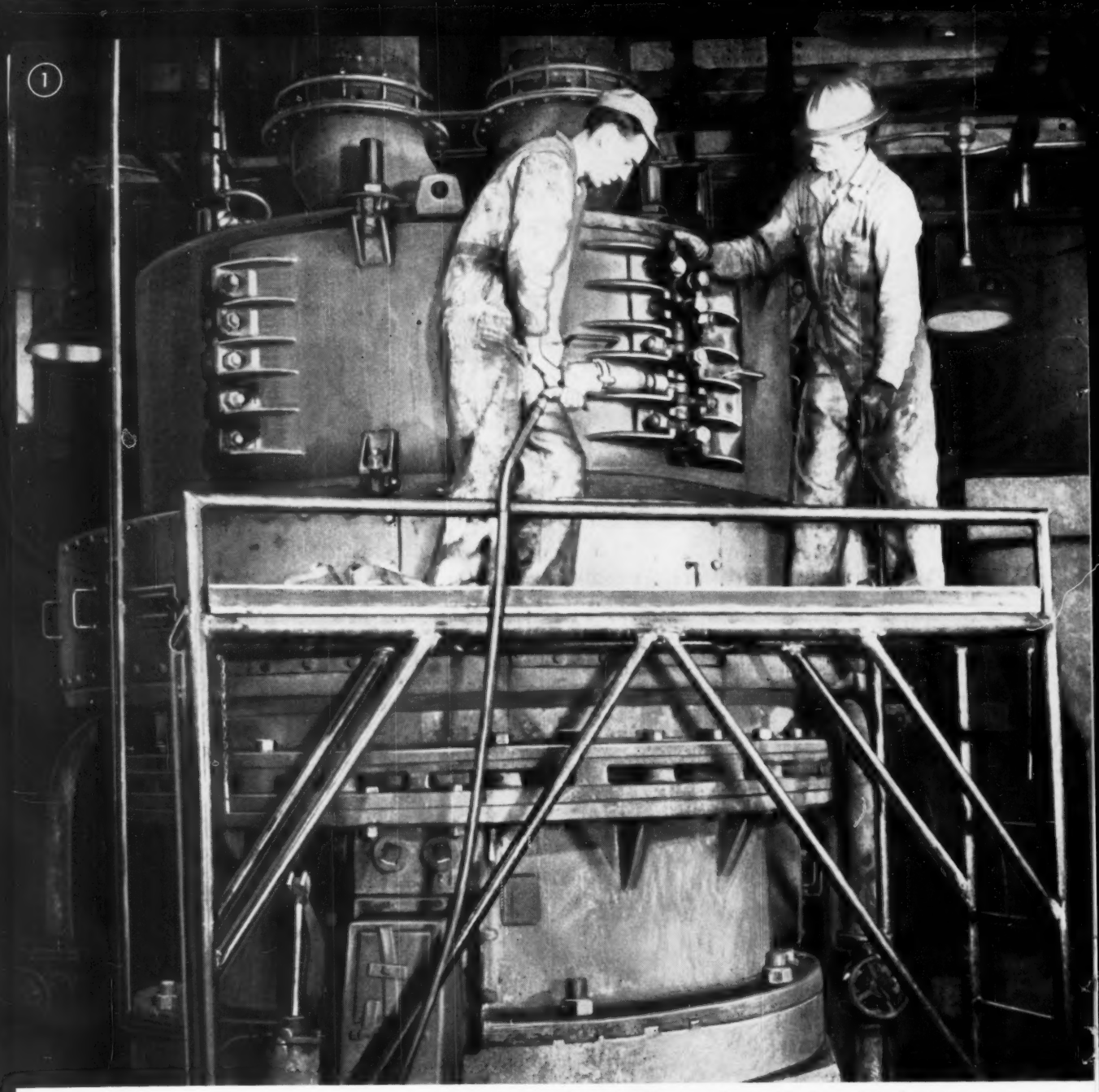


Representative steps in pulverizer disassembly shown here demonstrate ease and safety of maintenance. Access doors are opened by impact wrenches. Doors are swung back, not removed.

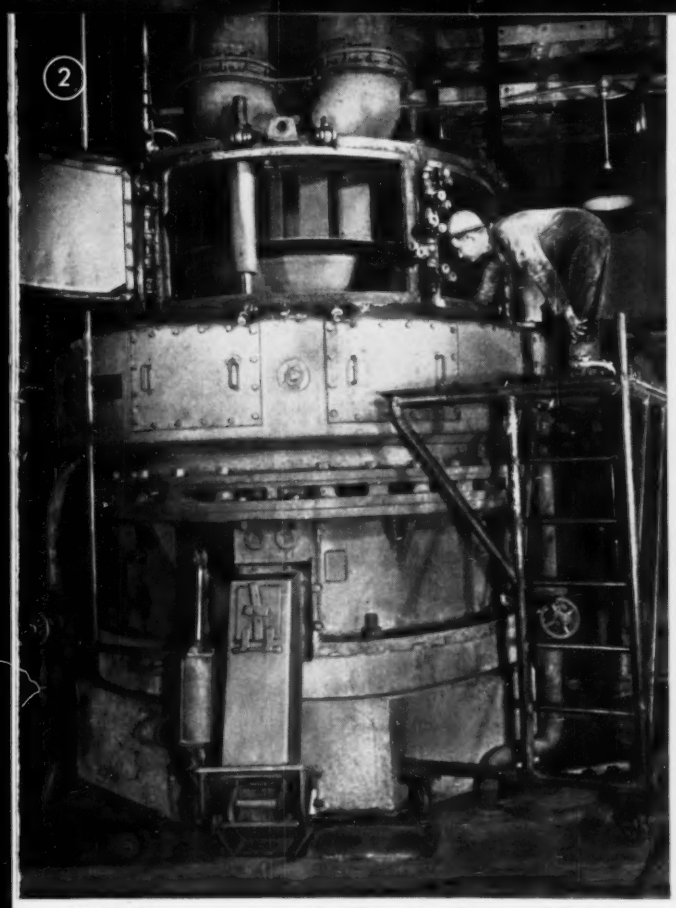
B&W Pulverizer Design Simplicity Cuts Maintenance

Compact Units Handle Low Grade Wet Coal Without Capacity Loss

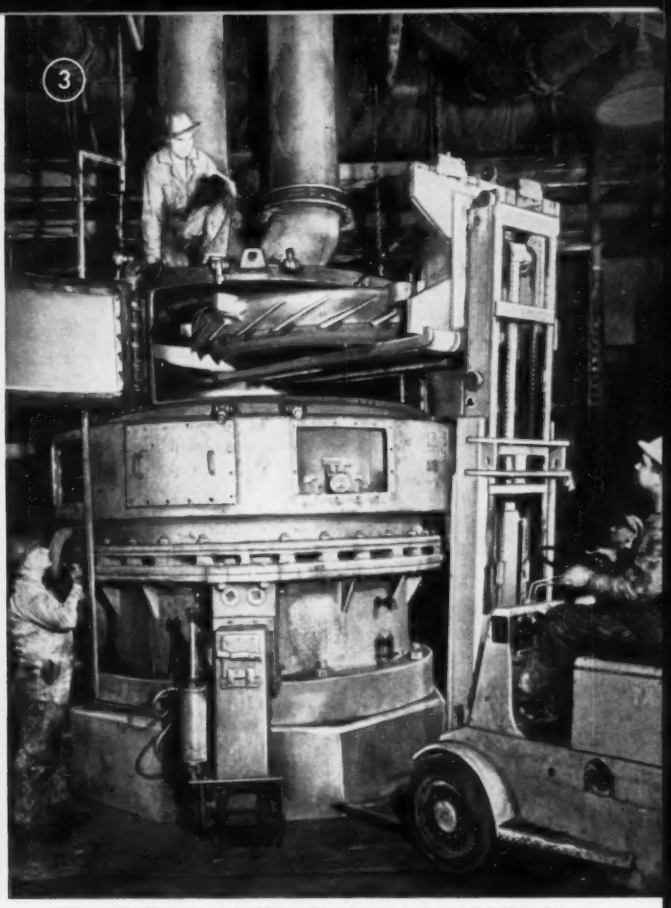
Exceptional output and efficiency records... highlighted by low maintenance... have been established in hundreds of installations by B&W Pulverizers. Their long-range dependability has been accompanied by reduced operating costs.

Fan Maintenance Minimized, shutdowns and maintenance costs reduced because the B&W Pulverizer primary air fan operates with only clean air. As primary air is supplied to the pulverizers under pressure, the fuel piping from pulverizer to burners is greatly simplified.

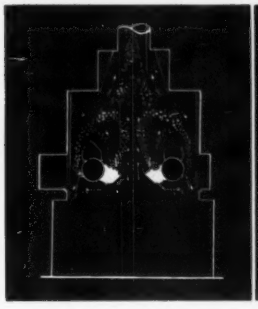
Continuous High Fineness, without reduction in capacity, is assured as grinding surface is maintained with wear. Slow-speed, spring loaded, ball bearing



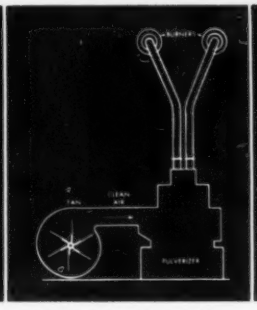
With doors swung open, classifier and spring assemblies are readily accessible for removal. Grinding components are lifted without special rigging.



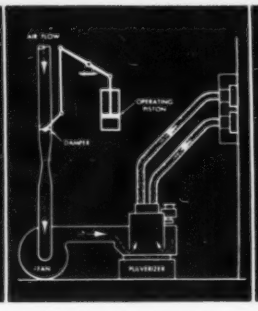
Top grinding ring is lifted by chain falls and, following removal of scaffolding, lifted and transferred by fork lift truck. Lower grinding ring is removed in same simple manner.



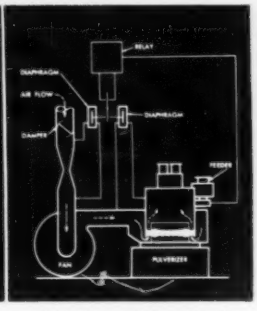
Coal Recirculation assures high fineness, aids drying.



Pressure System eliminates fan wear, simplifies piping.



Air Control maintained at one, simple contact point.



Mill Level Control automatically adjusts fuel-feed.

grinding elements of long-wearing, special alloy material maintain this proper grinding contact throughout their service life. Dependable classification permits only material of proper fineness to leave the unit.

Low Grade Coal, even wet coal, is handled efficiently. Exclusive B&W recirculation of fuel through heated air assures complete grinding, eliminates shutdowns, loss of capacity, and special attention from operators.

One-Point-Contact with the boiler simplifies operation. Boiler's automatic combustion control connects to the pulverizer at the damper in the primary-air duct. The unit's own control system regulates all other functions.

Continuous, Intensive Development by B&W engineers has brought excellent and measurable results to users of B&W Pulverizers. Supported by a national network of plants and engineers, B&W Pulverizers and Pulverized-Fuel Firing Systems open new avenues to operating economy. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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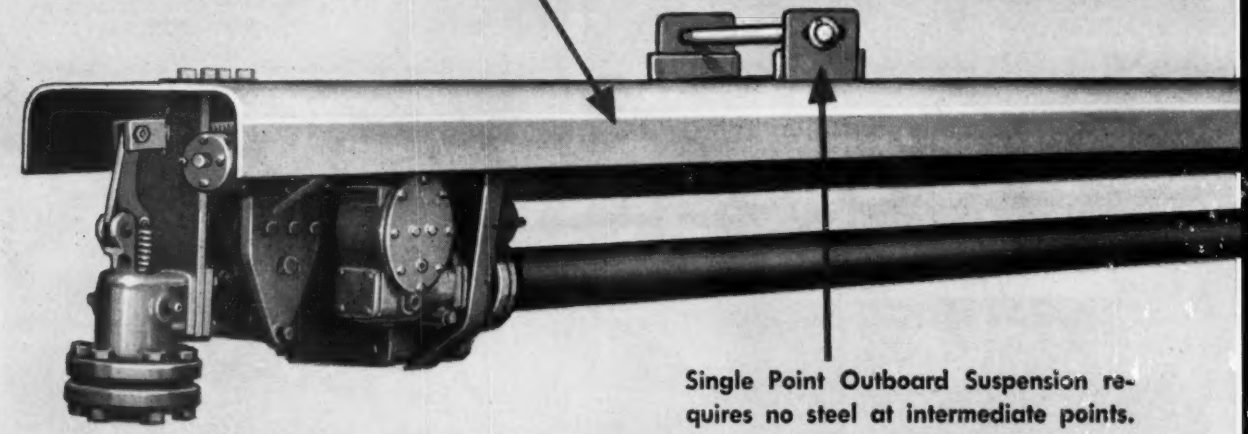
BOILER DIVISION

G-844

Backbone and Protective Cover

Top Cover is an integral part of the structural "Backbone" of the blower unit that assures greater rigidity. It also provides protection from dirt, damage, the elements, and personnel hazard . . . with improved appearance.



Single Point Outboard Suspension requires no steel at intermediate points.

One of the most popular features of the new Diamond Series 300 IK Long Retracting Blower is the very substantial cover that is formed from steel plate. It is much more than just a cover in the ordinary sense . . . it is also an integral part of the structural backbone of the blower that provides maximum rigidity without excessive weight.

This is only one of many important features (see box on right hand page) of the new Series 300 IK that is establishing a new standard of efficiency, economy and dependability in cleaning those heating surfaces that require a long retracting blower. For further information about the new Series 300 IK, ask the nearest Diamond office for Bulletin 2111U.

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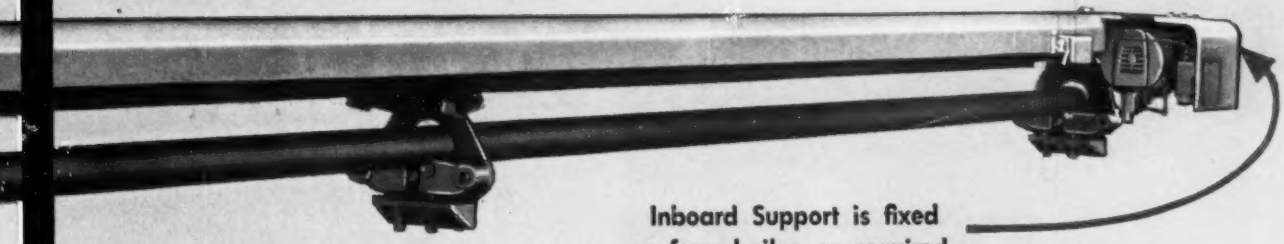


Inboard Support is fixed or from boiler, as required.

"YOU CLEAN BOILERS BETTER AND AT LOWER COST WITH DIAMOND BLOWERS"

OTHER ADVANTAGES OF SERIES 300 IK BLOWERS

- Front End Single-Motor Drive
- Compact, Accessible Electric or Air Power and Control Terminal Facilities
- Nozzle-Sweep-Every-Inch Cleaning Pattern
- Improved "Type A" Nozzle
- Positive Gear Carriage Drive
- Poppet Valve with Adjustable Pressure Control
- Positive Mechanically Operated Valve
- Single Point Outboard Suspension
- Oversize Lance (Step-Tapered for Extra Long Travel)
- Auxiliary Carriages for Extra Long Travel
- Designed for Quick, Easy Servicing

No other blower gives you all these advantages.

7697

AN UNMATCHED RECORD...

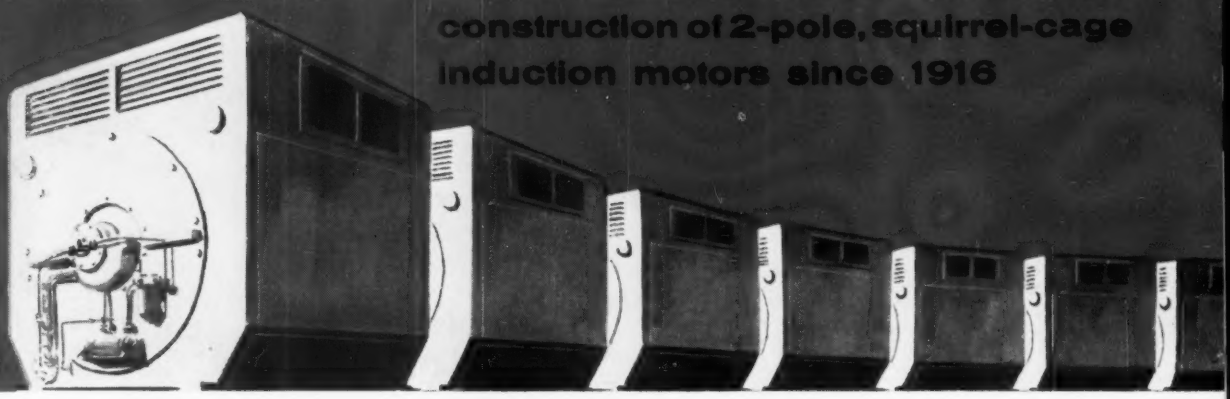
ELLIOTT has recently built or has on order

39 THIRTY-NINE

of the LARGEST 2-POLE MOTORS EVER BUILT

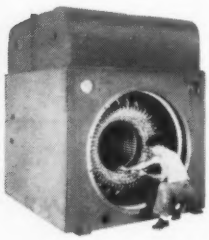
11 motors — each 4500 hp
24 motors — each 5000 hp
4 motors — each 6000 hp

SPECIALISTS in the design and construction of 2-pole, squirrel-cage induction motors since 1916



ONLY ELLIOTT has such a fabulous record-smashing history in large 2-pole motors

Elliott built the first large 2-pole motor in 1916. Since then Elliott has been a leader in building large 2-pole, squirrel-cage induction motors with designs progressively in advance of the power industry's constantly-expanding need for larger boiler feed pump drives. In 1956, Elliott built the first 5000-hp, 2-pole motor, and in 1957 it built four 6000-hp machines (like the one seen on the left)—again the largest of this type ever built—another world's record.



ONLY ELLIOTT has an 8-year field service record without one single operating electrical failure

Since 1948, 1,900,000 hp of large squirrel-cage induction motors with Fabri-Seal insulation have been put into service. The results shattered all previous records. Not one stator coil failed in over 8 years—due to insulation breakdown. Fabri-Seal Insulation combines the best of modern miracle insulations with ageless mica. Fabrication techniques are designed to permanently seal the coil against ravages of moisture, chemical fumes, dirt, etc., protecting your most vital auxiliaries against outages.

ELLIOTT Fabri-Seal INSULATION

Elliott's Fabri-Seal insulation system includes hand-wrapped mylar-backed mica at coil slot sections, special sealing at vulnerable points, vacuum and pressure impregnation of all coils, coil and complete stator immersing, and turn-to-turn testing at high voltages.

ONLY ELLIOTT has consistently pioneered in advanced, superior designs

Elliott introduced Fabri-Steel construction "tailoring in metal" to large 2-pole machines . . . brought out the first *really* outdoor motor which subsequently led to an entirely new NEMA classification—the "weather-protected" motor . . . and consistently fabricated superior stator coil insulation (achieving astounding records of 20, 30, and 40 years of service) even prior to the development of Fabri-Seal insulation, which achieved an 8-year record. In "super-quiet" 2-pole motors also, Elliott was first—following years of research and development in acoustical design problems.

ASK YOUR OPERATING PERSONNEL

They'll tell you it pays
to install Elliott-designed machines

Wherever Elliott 2-pole induction motors are on the job . . . operating personnel have expressed pleasure at their dependable, trouble-free service.

Here are typical comments:

"What more could you ask for in a motor."
"The noise level is out of this world."
"Your access openings are better than our fondest expectations."

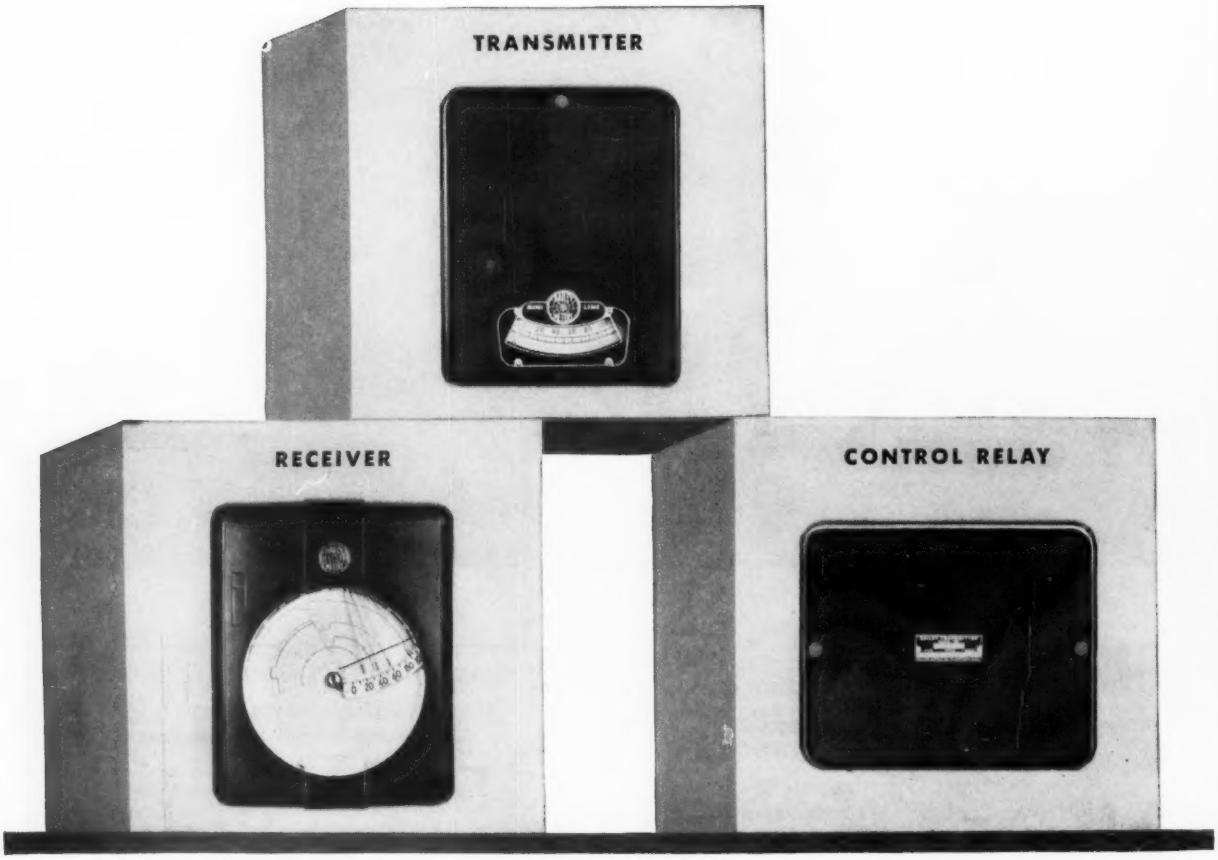
Try it yourself. Ask your operating man—he'll tell you Elliott 2-pole machines give the best and longest trouble-free service. Call or write for complete details today.

ELLIOTT Company
RIDGWAY PLANT, RIDGWAY, PA.

RB-3

get your powerhouse motors from the people who build them best

How to simplify



The Bailey Building Block Method enables you to simplify control problems by combining standardized measuring, transmitting, and controlling components as required.

control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.

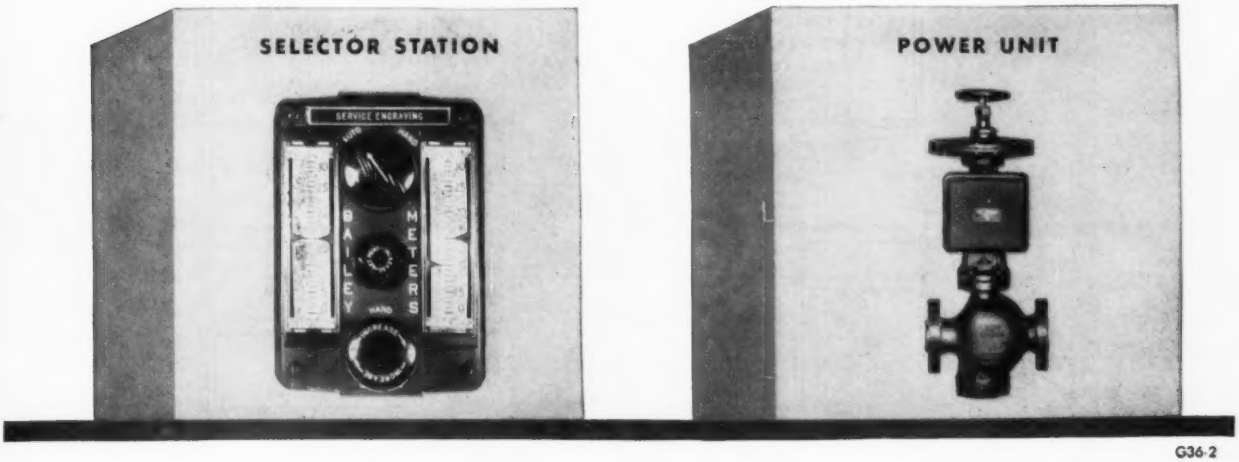
What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is steam flow, tank level, or heater temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, call our local district office or write us at Cleveland. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.



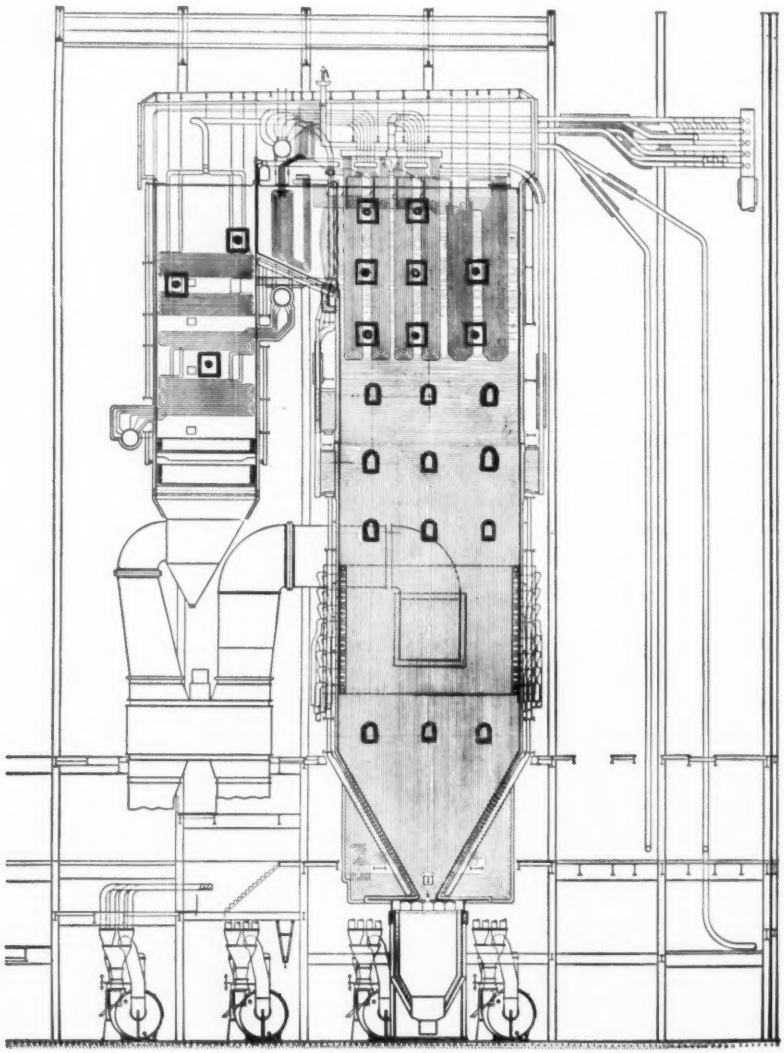
G36-2

BAILEY METER COMPANY
1036 IVANHOE ROAD, CLEVELAND 10, OHIO
In Canada—Bailey Meter Company Limited, Montreal

BAILEY BUILDING BLOCK METHOD

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

It's Vulcan Selective-



PHILADELPHIA ELECTRIC COMPANY, EDDYSTONE STATION, UNIT 1
Capacity—2,000,000 lb/hr at 5000 psig and 1200/1050/1050/F.
C-E Sulzer Monotube Steam Generator

Section shown is of the high-pressure reheat furnace

Sequence for Eddystone Station

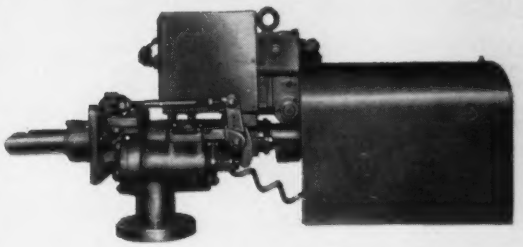
Philadelphia Electric's new super-critical steam generators at Eddystone Station will be equipped with Vulcan Selective-Sequence soot blowing systems. Included in the systems for Units 1 and 2 are Vulcan T-30 long retractables with 30- and 37-foot travels, half-'tracts with 19-foot travel from 18-foot permanent extension into the furnace. RW-3E wall deslaggers and air-preheater cleaner controls will also be used.

Selective-sequence control was chosen because it provides positive soot blower operation at proper intervals in precisely the sequence necessary for effective cleaning. The entire blowing cycle will be supervised from a compact, completely pre-wired panel.

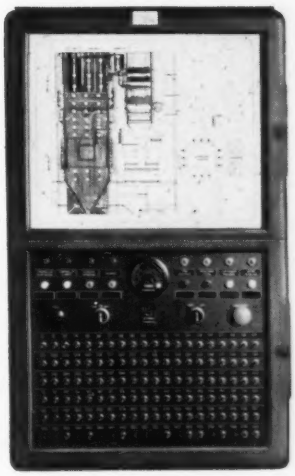
Modern Vulcan soot blowing systems, with either automatic-sequential or selective-sequence control, can help keep your boilers operating at peak efficiency. Your Copes-Vulcan representative has the ideas, information and experience to help you choose the system best suited to your needs.

COPES-VULCAN DIVISION
BLAW-KNOX COMPANY
ERIE 4, PENNSYLVANIA

C-V NEWS NOTES

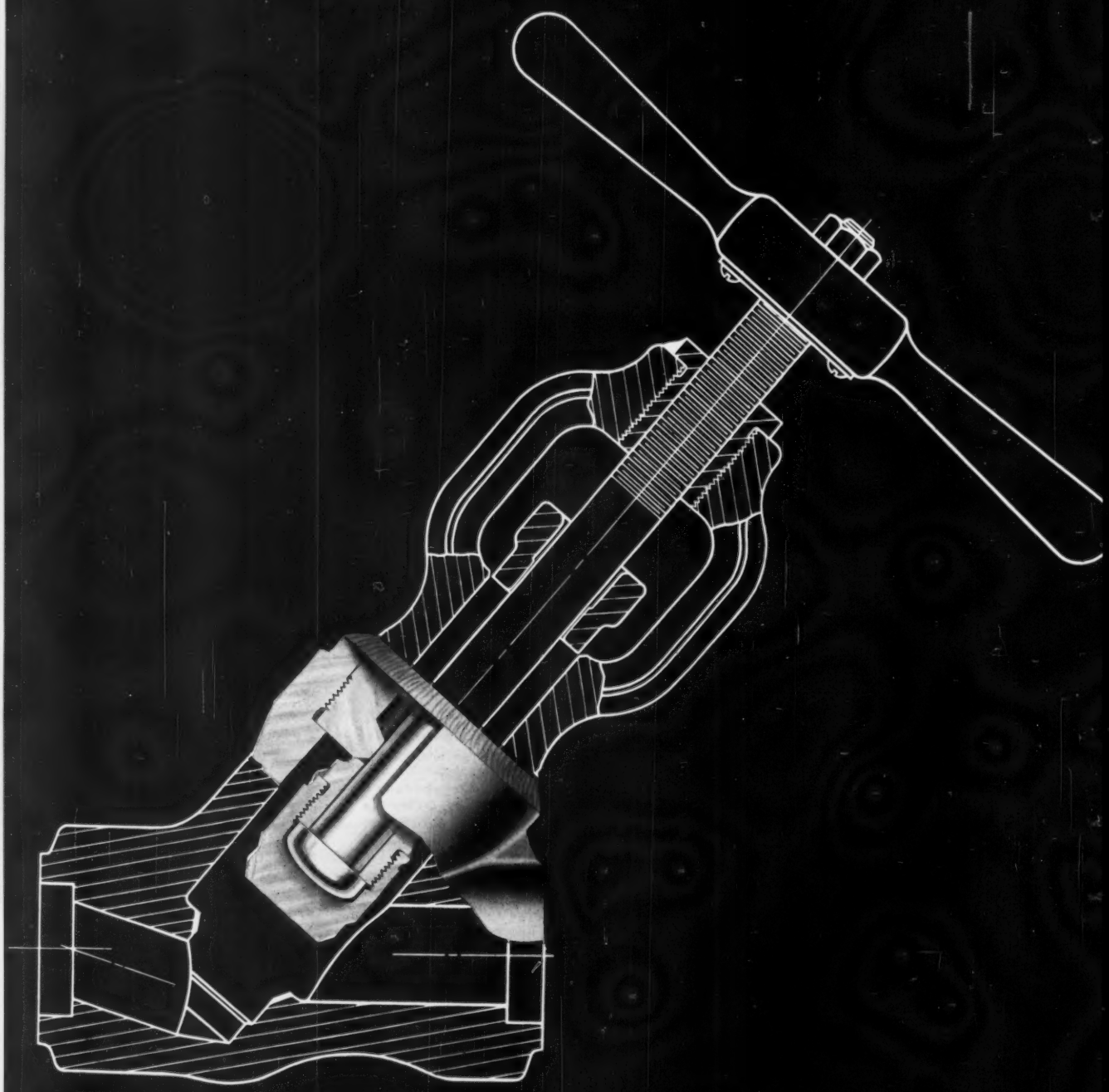


Vulcan RW-3E wall deslagger has dual-motor electric drive. One motor extends and retracts the lance, the other rotates the nozzle. Action is rapid and positive.



Rifle precision, with up to four complete cycles for each soot blower in any pre-selected sequence, is controlled from this completely pre-wired, factory-assembled SSC-120 Vulcan Selective-Sequence Controller. Long retractables and wall deslaggers can be inter-mixed in the sequences. 60-station Model SSC-60 also available.

Bulletin 1030 illustrates and describes the Vulcan T-30 long retractable soot blower as selected for Eddystone Units 1 and 2. Your Copes-Vulcan representative can give you a copy, or write direct to the factory.



EDWARD UNIVALVE

What's New from Edward Valves, Inc.

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

Shoulder, thread and weld make

Superior "Univalve" Body-Bonnet Joint

Edward valve researchers were assigned three main goals in developing the Univalve* . . . first, design a globe valve for high pressure-temperature service—that would *stay* leak-proof . . . second, eliminate—as far as possible—the necessity for maintenance . . . third, fabricate all pressure-containing parts of forged steel for maximum strength and soundness.

How well they succeeded is illustrated by this fact: in many hundreds of advanced temperature-pressure applications all over the world, Edward Univalves have given consistently superior service. The *reason* for this is simple . . . Univalves, properly maintained, simply do not leak.

WELD SEALS JOINT

In the Univalve, a bead of fine-grained weld seals the body-bonnet joint to maintain perfect pressure tightness in any service. A guiding section above the threads protects them from the seal-weld; the threaded section and body shoulder carry the pressure load and insure accurate alignment. The rugged threaded bonnet—with opening just large enough to accommodate the stem—provides a pressure-tight backseat. The radiused disk nut contacts the beveled bonnet backseating surface . . . isolates packing from line pressures and temperatures . . . stretches packing life.

While the Univalve rarely needs attention, even its tough integral Stellite seating surface *can* become scored under some conditions. To strip for inspection and possible re-lapping, the seal-weld is easily removed by machining or grinding or with carbon arc or oxy-acetylene scarfing tip. Besides simple disassembly and positive backseat advantages, Univalve's one-piece gland eliminates possible small parts loss during repacking.

IDEAL FOR BLOW-OFF SERVICE. Univalves meet ASME Code for blow-off service and are adaptable for all high pressure installations.

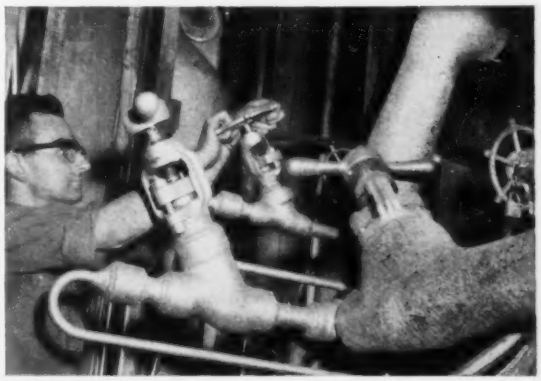
IMPORTANT UNIVALVE FEATURES:

Streamlined Flow Path reduces pressure drop, minimizes wear-producing turbulence. Univalve meets requirements for blow-off service.

Simple Packing Adjustment keeps packing maintenance down. Sturdy gland bolts, roomy yoke, one-piece forged gland.

Easy Open—Tight Close Operation of all Univalves 1¼" to 2½" made a reality with the exclusive Edward Impactor* handle.

Continuous Stellite Ring applied to body and disk, retains hardness under temperature and resists wear.



4500 LB UNIVALVE in service at Ohio Power Company's supercritical Philo station.

*T.M. Reg. U.S. Pat. Off.

EDWARD VALVES, INC.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

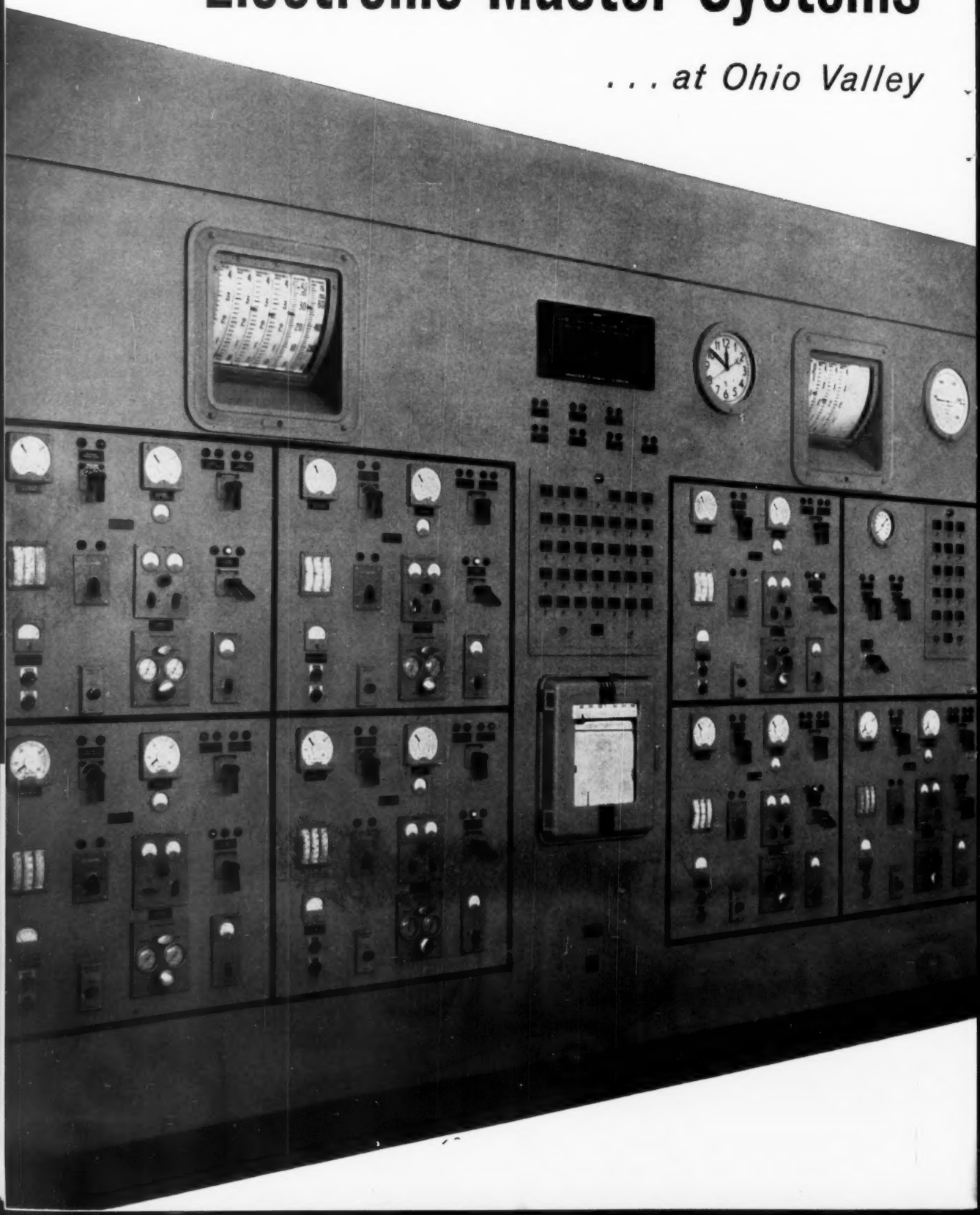
1230 West 145th Street, East Chicago, Indiana

Edward builds a complete line of forged and cast steel valves from ⅛" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, instrument, gage and special designs; for pressures up to 7500 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

ANOTHER REPUBLIC ACHIEVEMENT!

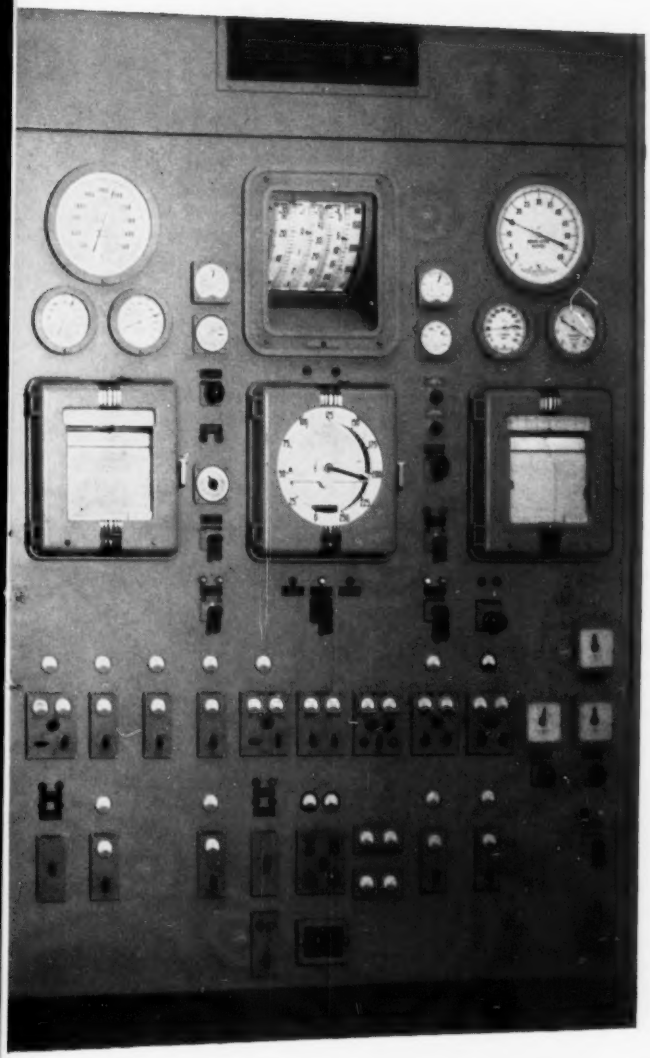
Electronic Master Systems

. . . at Ohio Valley



Control Five 1,400,000 lb/hr. Boilers

Electric Corporation's Kyger Creek Power Plant



One of Kyger Creek's five Republic control centers. An Electronic Master operates to provide electric signals for pneumatic power positioners on 7 coal pulverizers, 2 F. D. fans and 2 I. D. fans on each boiler.

Five large boilers in this plant produce a million kilowatts for our nation's atomic energy program. Multiple components on each boiler must work simultaneously as a single unit, in order to operate at maximum efficiency under all loads. A Republic *load-sensing* combustion control system with an Electronic Master regulates all these inter-related functions . . . counters every fluctuation in steam flow with corrected fuel and air flow settings without waiting for variations in steam pressure. An integral *pressure* control system makes final corrections in control signals (if necessary) to hold steam pressure constant.

Republic's experience with plants of all sizes, all pressure and temperature ratings, and all load characteristics is your best guarantee of getting all the premium performance built into your major equipment. A technically-trained, thoroughly experienced Republic Sales Engineer is ready to discuss your instrument and control problems. Republic sales offices are located in principal cities throughout the country.

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

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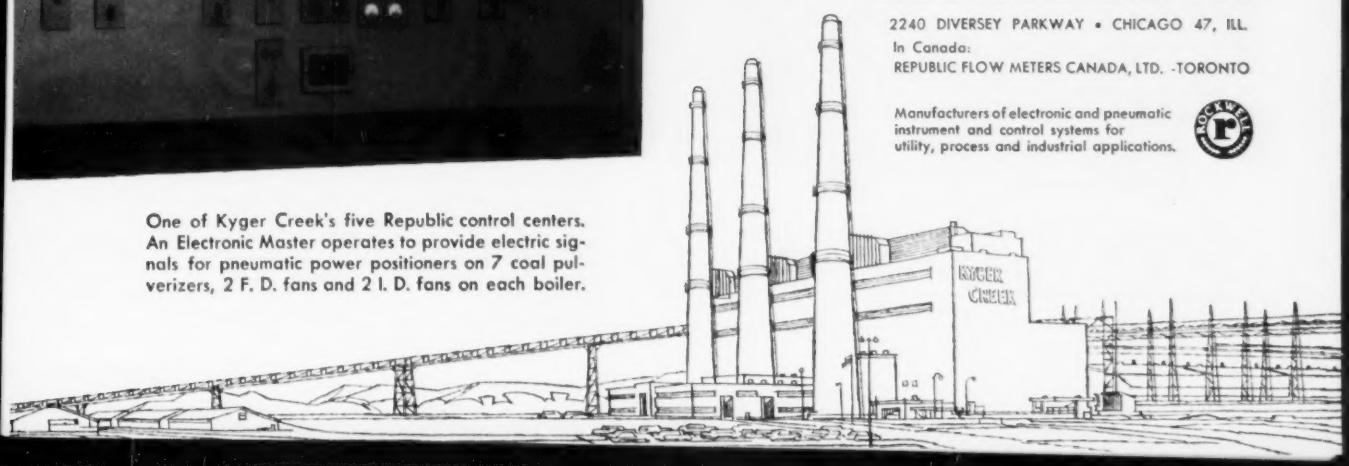
In Canada:
REPUBLIC FLOW METERS CANADA, LTD. -TORONTO

Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.



Revolutionary Performance!

Riley Boiler Unit gives bonus of 20,000 pounds per hour of steam to Masonite Corporation

Here's the maximum capacity guaranteed to Masonite by Riley Stoker Corporation:

50,000 lb. continuous
60,000 lb. for 15 min. peaks

And here's the Masonite report on performance: "For the past 75 days the average hourly load on the new boiler has been 70,000 pounds with peaks of one and more hours' duration of 75,000 pounds."

This same installation called for a guaranteed air heater gas temperature not in excess of 395 degrees at 50,000 pounds of steam per hour. In actual operation at 54,500 pounds of steam per hour, the air heater exit gas temperature was only 377.5 degrees!

No wonder Riley Stoker Corporation, Worcester, Massachusetts, is so well known among leading plants throughout the nation for the highly efficient performance of its boilers!

Coppus-Dennis FANMIX Burners Were Installed

To assure such revolutionary performance, Riley specified Coppus-Dennis FANMIX Burners for its boilers. The exclusive FANMIX action — on *all* Coppus burners, gas as well as combination gas-oil — is the reason for such performances.

FANMIX : Better Combustion : Better Efficiency : Higher Ratings

FANMIX burners, with their *revolving orifices*, give violent mechanical mixing and agitation of gas and air and, therefore, instantaneous and complete combustion with *minimum excess air* (5% excess air not unusual).

Furnace space is not required for mixing; therefore, *higher boiler ratings* are easily obtained.

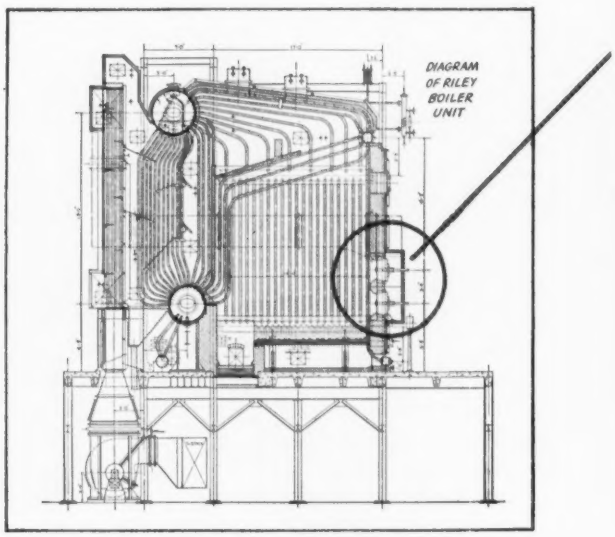
FANMIX burners, with shorter flame than any other burner, cannot cause flame impingement.

FANMIX burners, incorporating a *fan* as an integral unit, have *no draft loss* across the burner. Therefore, regardless of draft conditions, increased ratings are possible.

FANMIX action, with its quick completion of combustion, gives *lower* exit gas temperatures.

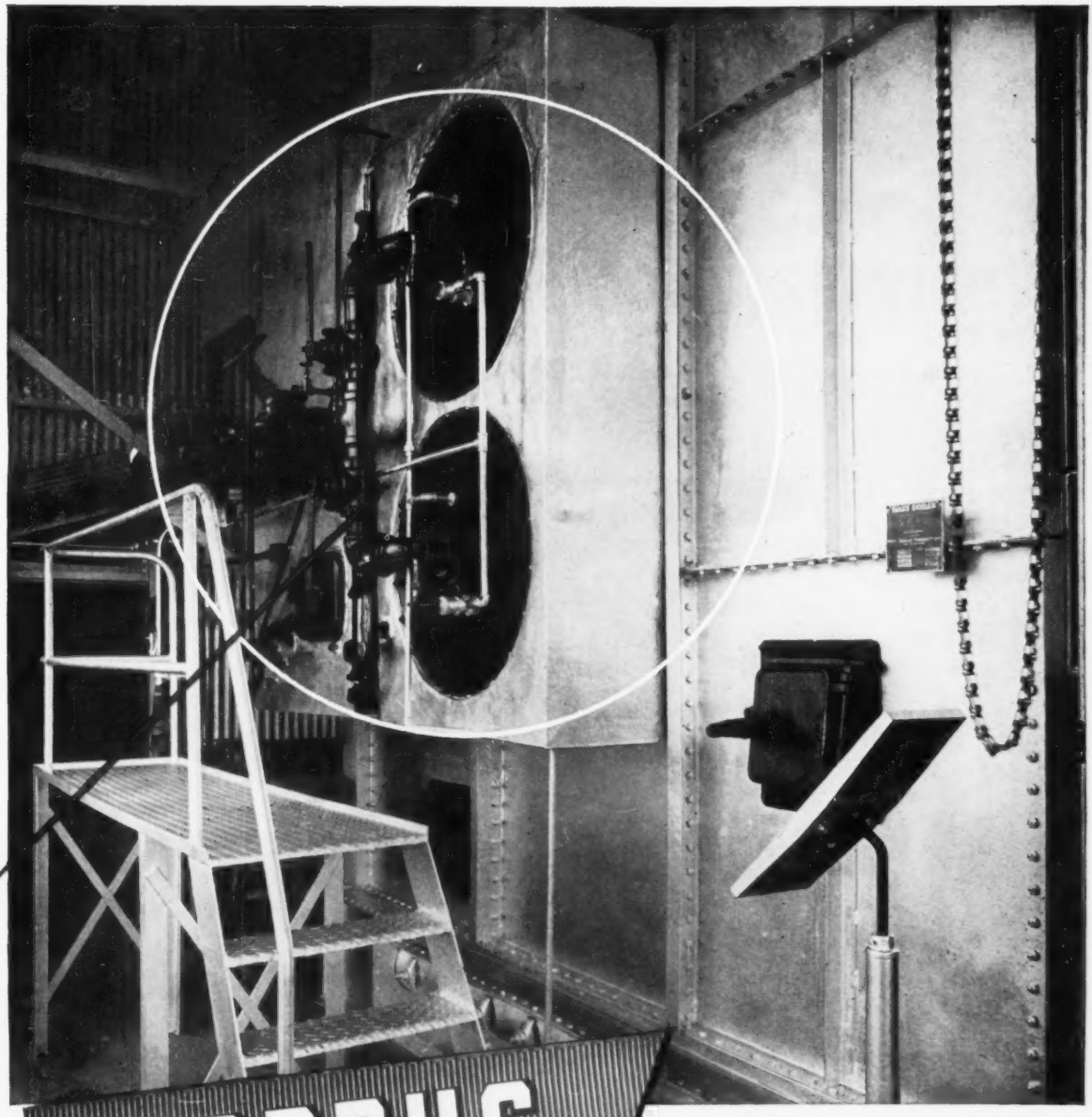
Plan now to take advantage of Coppus-Dennis FANMIX action with your present boiler. Remember — no forced draft equipment nor increase in stack nor increase in furnace volume is required for *FANMIX* operation to get increased capacity. And on *new* boilers, FANMIX lets you plan on reduced combustion space, higher ratings, less stack height or reduced induced draft capacity, and *no* forced draft equipment. Mail coupon today. Sales offices in *Thomas' Register*. Other "Blue Ribbon" Products in *Chemical Engineering Catalog, Refinery Catalog, Best's Safety Directory, and Mining Catalogs.*

JET REACTION is utilized to rotate fan which is integral part of burner. Automatically proportioned high velocity air passes at right angles through fuel to create ideal mixture for fast, complete combustion and peak efficiency.



Well-Known Users of Riley Units with FANMIX Burners Include:

Publicker Commercial Alcohol Co.
Monsanto Chemical Co.
Gaylord Container Corp.
Commercial Solvents Corp.
Celanese Corp. of America
Gulf Power Co.
Mississippi Power Co.
Eagle-Picher Lead Co.
Humble Oil & Refining Co.
Godchaux Sugars, Inc.
Kennecott Copper Corp.
Nicholson File Co.
Bird & Son, Inc.
— and many others



RILEY BOILER UNIT, using FANMIX burners, is here shown as installed for the Masonite Corporation, Laurel, Mississippi. Circle in diagram at left indicates position of burners pictured above.

COPPUS

FANMIX® BURNER

GAS - COMBINATION GAS-OIL

SEND COUPON for further information. Coppus engineers FANMIX burners to your individual requirements.

PLEASE ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

COPPUS ENGINEERING CORPORATION
162 Park Avenue
Worcester 2, Massachusetts

Please send complete data on Coppus-Dennis FANMIX Burners. I'm particularly interested in
☐ gas ☐ combination gas-oil.

Name..... Title .....

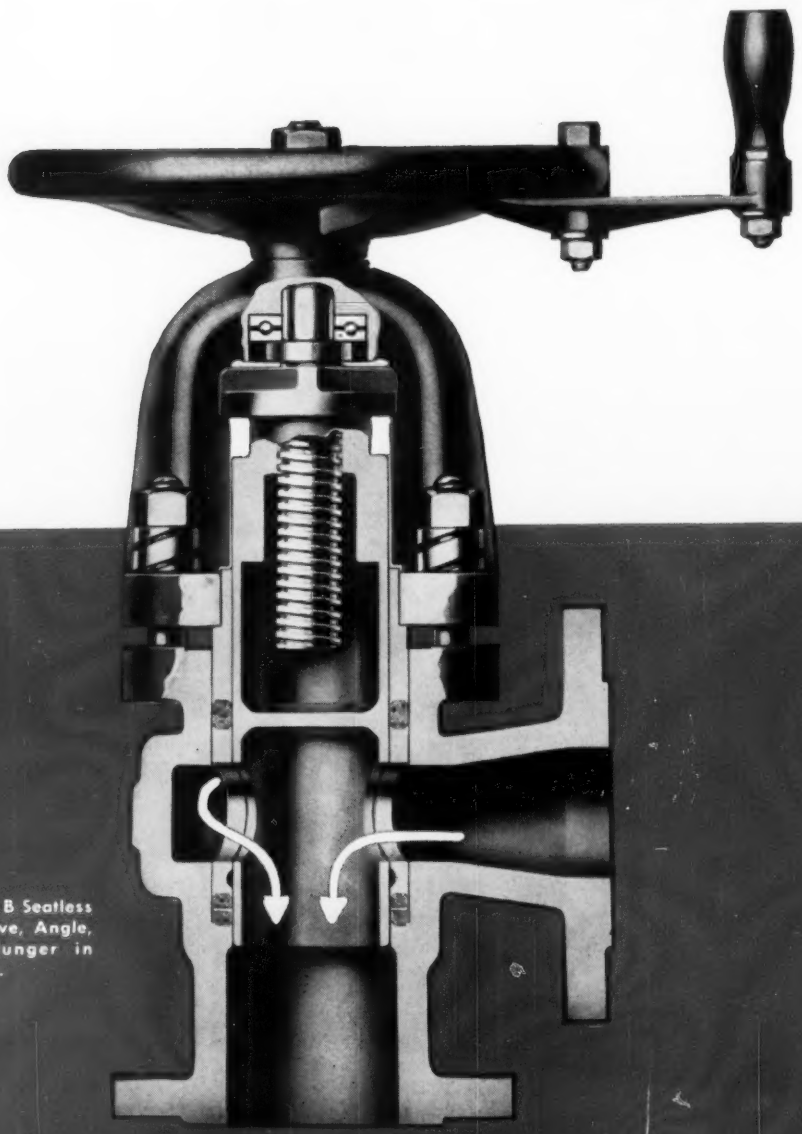
Company.....

Address.....

City..... Zone..... State.....

seatless

. . . for



Yarway Type B Seatless Blow-Off Valve, Angle, showing plunger in open position.

YARWAY

trouble-free blow-down service

YARWAY SEATLESS BLOW-OFF VALVES

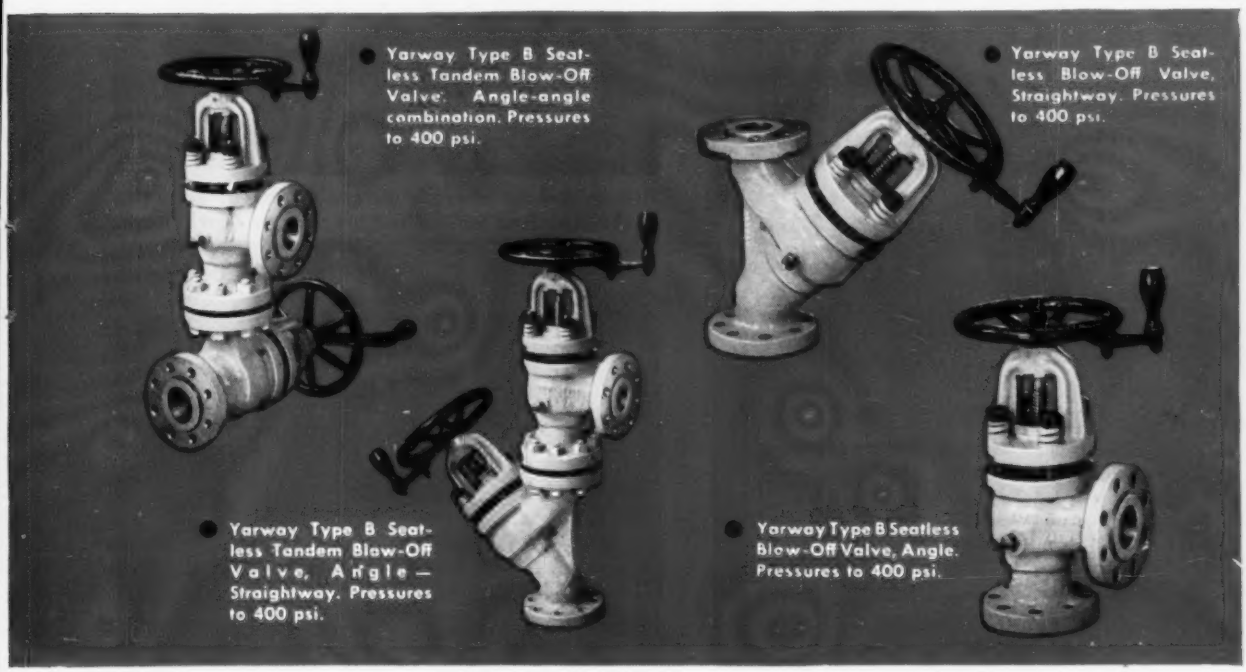
"Trouble preventers" is what YARWAY Seatless Blow-Off Valves are often called because they eliminate one of the commonest sources of trouble in low and medium pressure boiler blow-down service. *There is NO SEAT to score, wear, clog or leak.*

YARWAY Seatless Blow-Off Valves feature a balanced, sliding, hollow plunger design that permits free and easy operation—full, unobstructed flow.

More than 16,000 boiler plants today use YARWAY *Blow-Off Valves.*

YARWAY Bulletin B-426 shows all the latest types and features of YARWAY Seatless Blow-Off Valves. If you operate your boilers up to 400 psi, you'll find a copy helpful. For higher pressures, ask for Bulletin B-434. Write today.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

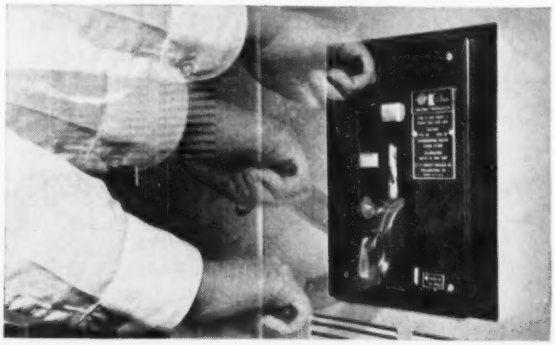

Yarway Type B Seatless Tandem Blow-Off Valve. Angle-angle combination. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Straightway. Pressures to 400 psi.
Yarway Type B Seatless Tandem Blow-Off Valve, Angle—Straightway. Pressures to 400 psi.
Yarway Type B Seatless Blow-Off Valve, Angle. Pressures to 400 psi.

— blow-off valves

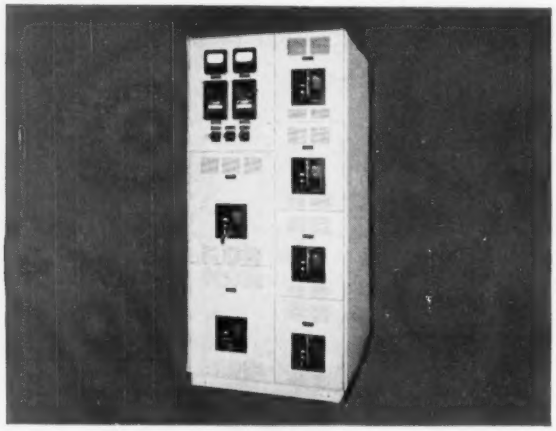
I-T-E makes sweeping design advances in new low voltage power circuit breakers, switchgear

I-T-E's new K-Line offers better performance, greatly simplified operation and servicing, and standardization in construction and assembly

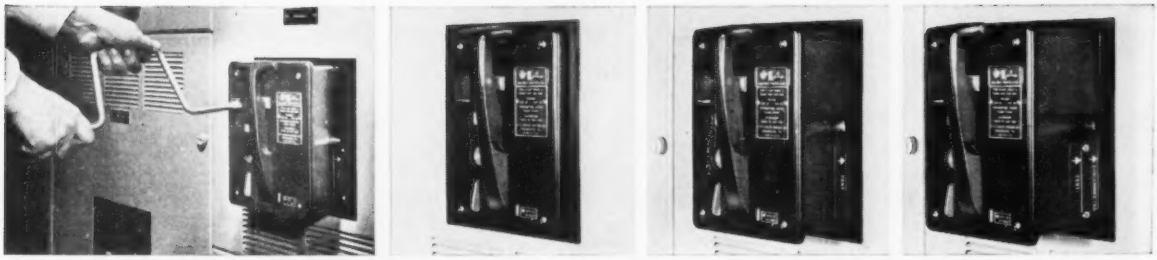
Now we offer a complete new design of equipment for the switching, control and protection of motor, generator, transformer and feeder circuits, as well as other large electrically powered facilities—the most sweeping design advance in 13 years. Among the major innovations in the new design are the following.



First quick-make manually charged stored energy closing mechanism. First 90% of pulldown handle travel charges spring mechanism, last 10% releases stored energy, automatically closes contacts. No teasing of contacts is possible.

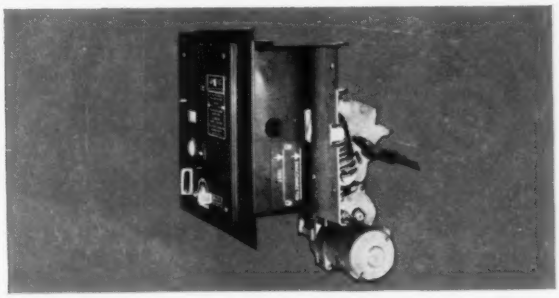


4-high stacking of 600 amp frame size circuit breakers in 90-in.-high enclosures. The new circuit breakers are as much as one-third smaller and 55% lighter than comparable units. The new switchgear is the smallest ever designed.

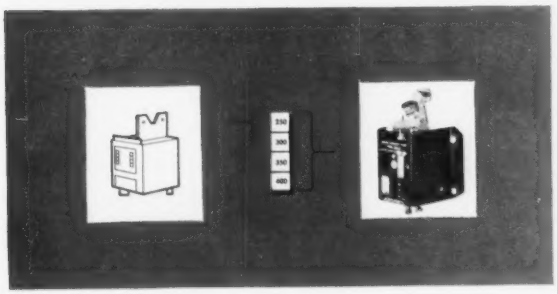


First closed-door drawout of circuit breakers. This permits racking of circuit breaker into connected, test and disconnected positions without opening the door of the circuit breaker compartment. Drawout arrangement keeps circuit breakers clean, aisles uncluttered, promotes personnel safety. Breaker must be opened before shutter can be lifted to insert drawout racking crank. Breaker cannot be closed while shutter is lifted.

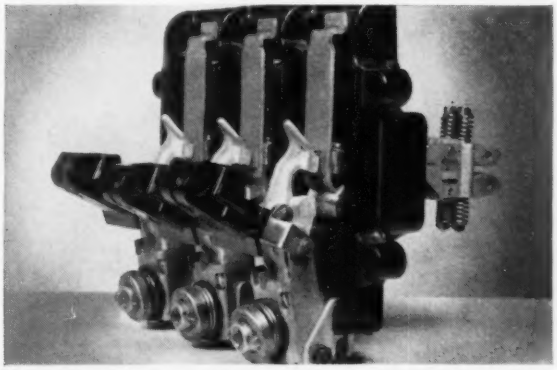
Greatly increased accessibility to component parts for operation and servicing. For example, trips on electrically and manually operated breakers are out in the open and can be easily adjusted. Trips also can be changed quickly. One-piece molding holds trip units, which are changed from the rear and in a fraction of the time formerly required.



Stored energy electrical closure that materially cuts control circuit requirements. The motor-driven stored energy system requires only 10 amp from a simple power source, compared to as much as 160 by comparable solenoids. Quick-make manual closure operates on same principle. First 90% of pull-down handle travel charges a spring mechanism. Last 10% releases the stored energy and closes the contacts. No teasing.



Expanded trip flexibility meets last-minute load changes in many instances with the existing trip unit.



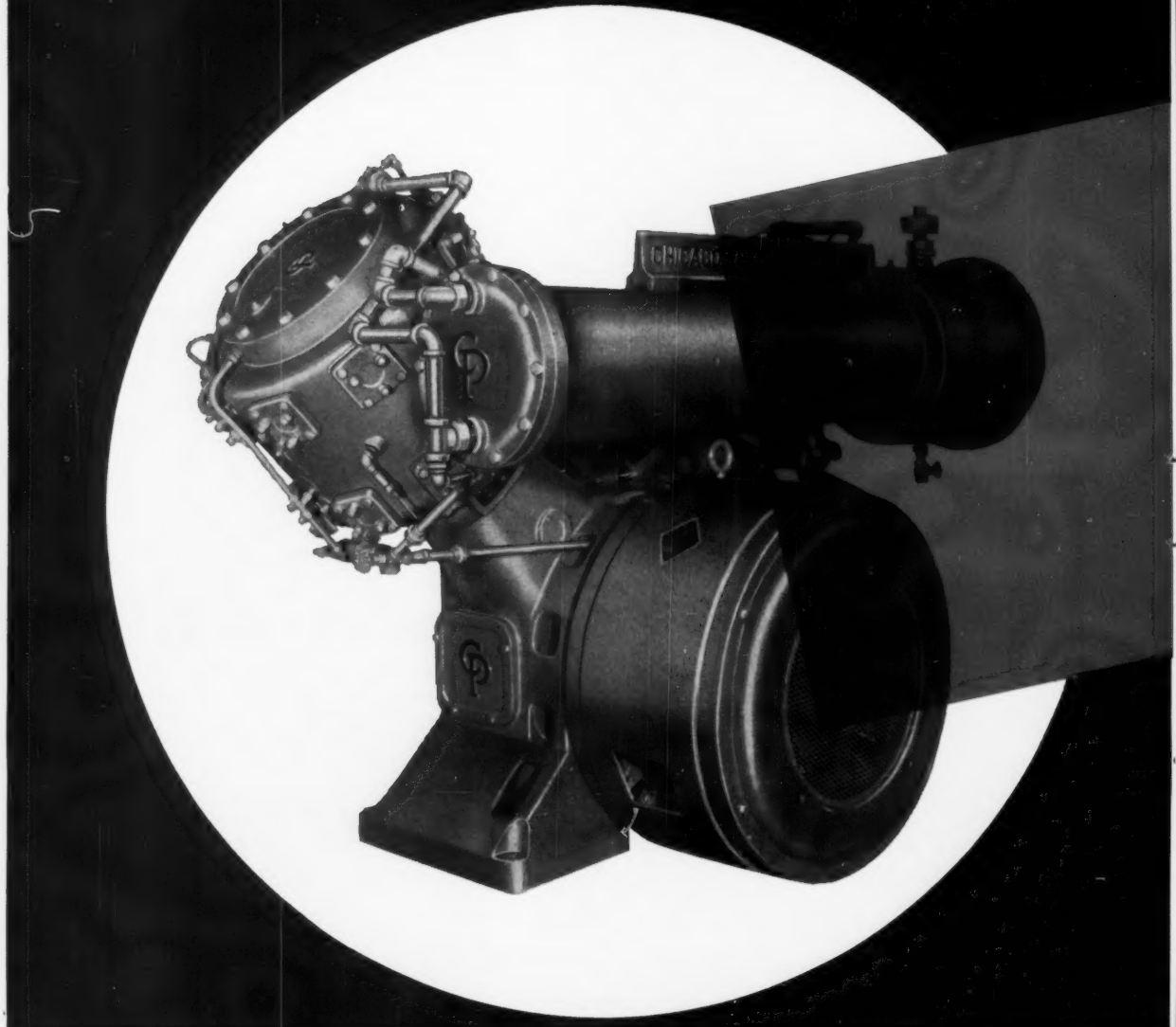
Subassembly circuit breaker construction permits easier, faster replacement of parts. Six major subassemblies replace 130 separate parts in previous models. A part replacement formerly requiring an all-day overhaul of the circuit breaker may mean only removing and replacing a unit subassembly—a matter of minutes.

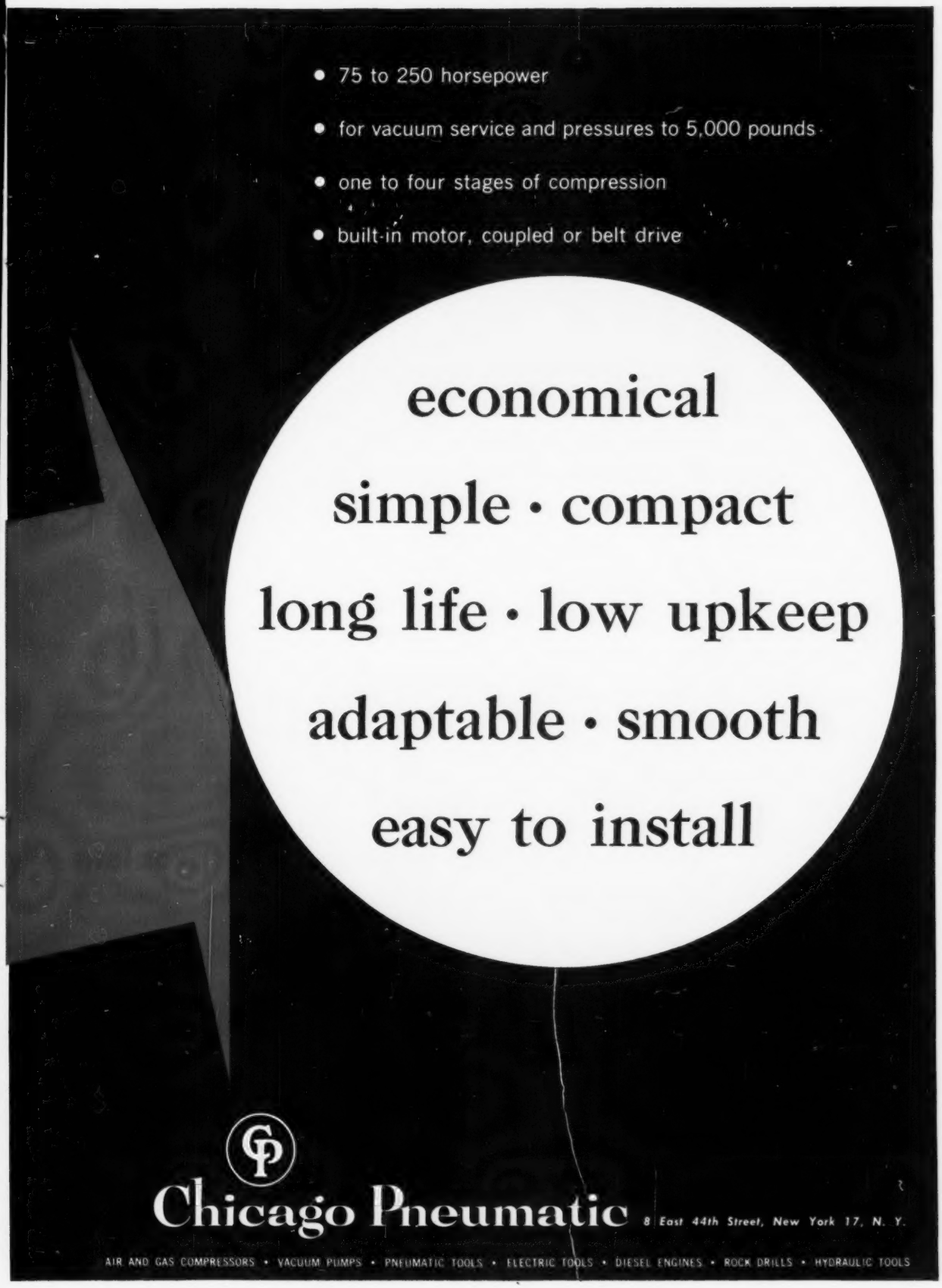
Bulletin 6004C tells the complete story of this advanced design switchgear. Ask your local I-T-E representative for a copy today. Or write I-T-E CIRCUIT BREAKER COMPANY, Switchgear Division, 19th & Hamilton Sts., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

19TH AND HAMILTON STREETS. PHILADELPHIA 30. PENNSYLVANIA

TYPE "Y"
PACKAGE TYPE
STATIONARY
COMPRESSORS




• 75 to 250 horsepower
• for vacuum service and pressures to 5,000 pounds
• one to four stages of compression
• built-in motor, coupled or belt drive
economical
simple · compact
long life · low upkeep
adaptable · smooth
easy to install
Chicago Pneumatic
8 East 44th Street, New York 17, N. Y.
AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

solves your jointing problem

The original compressed asbestos jointing, Klingerit was first manufactured over seventy years ago, and is used today in ships, refineries, chemical and power plants all over the world.

Specially suitable for HIGH PRESSURE, HIGH TEMPERATURE problems, it resists the action of steam, hot and cold water, hot and cold oils, petrol, benzine, the by-products of the coal industry, most acids, and chemicals in general. It will not burn, disintegrate or squeeze out. Thicknesses from .008″ to $\frac{1}{4}$″. Sheet sizes to 60″ x 160″.

Available from distributors in all principal cities.

FIRST IN 1909 Klinger FIRST TODAY

For descriptive leaflets and literature write to:—

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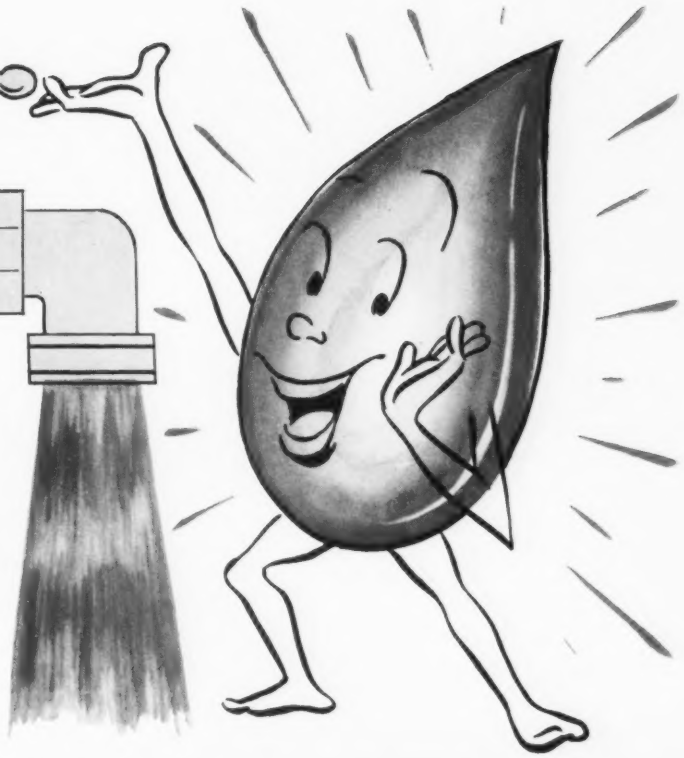
ALLIS-CHALMERS

Water Conditioning



Announcing New Industrial Zeolite Water Softener

Basic standard water softener designs easily adapted to meet individual plant requirements.

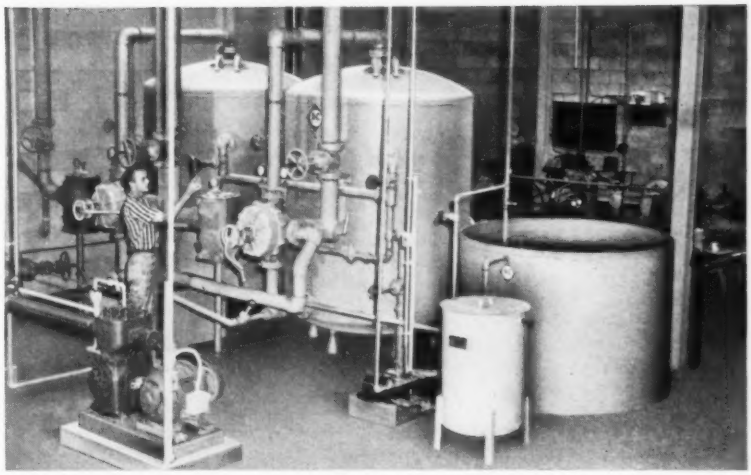
Here's a well-engineered, well-built answer to a wide range of water conditioning problems. It's designed to eliminate costly maintenance due to scaling of pipes and heat exchange tubes; to produce chemically suitable water for drying, paper making, textiles; and to provide water for food processing and many special industrial applications.

Easy Operation

The unit is basically simple. It is engineered to operate with little or no maintenance between regenerating cycles. Regeneration is an easy procedure. Automatic controls are also available to further simplify the operation if desired.

Standard Basic Design

Allis-Chalmers engineers started with a basic standard design developed from years of research and experience.



Allis-Chalmers sodium zeolite water softener installed in Ohio dye plant.

From this, a water softener is engineered to meet your individual plant requirements. Such factors as size of softener tank, size of salt and brine tank can be varied to meet your conditions.

Get Details

For complete details about Allis-Chalmers industrial type zeolite water softeners, call your nearby A-C office or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS A-C ALLIS CHALMERS

A-5552

STOCK

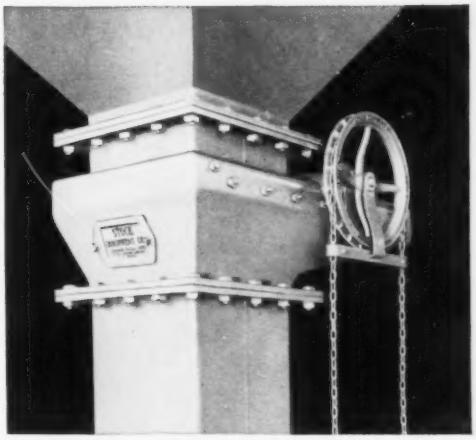
Dramatic "upside down" test tells

The inside story on the S-E-CO Coal Valve...

The simple test illustrated here proves graphically that the S-E-CO Coal Valve works under almost any kind of condition—even while it's standing on its head.

One reason for the superiority of the S-E-CO Valve is the exclusive self-cleaning design of the racks and pinions. Double pinions on either side of the gate project *through* the ladder racks, because the root portions of the racks have been eliminated. There is no place for coal to build up and cause jamming or cocking. This self-cleaning design helps the S-E-CO Valve operate smoothly and easily, even after long periods of infrequent use.

There are many other features that help to make the S-E-CO Coal Valve your best valve buy. Just one word of caution. Be sure to install *your* S-E-CO Valve right side up. It works even better that way.



BUILDING THE STANDING COLUMN

Valve is inverted and filled with coal. In this position racks and pinions are exposed. Normally an extra deep U-shaped gate protects them from contamination by coal particles.

PACKING THE COAL AGAINST PINIONS

2 x 4 is used to spread coal through valve and pack it against pinions (see opposite page). Don't forget, the valve gate must force its way through the coal that already fills the valve.

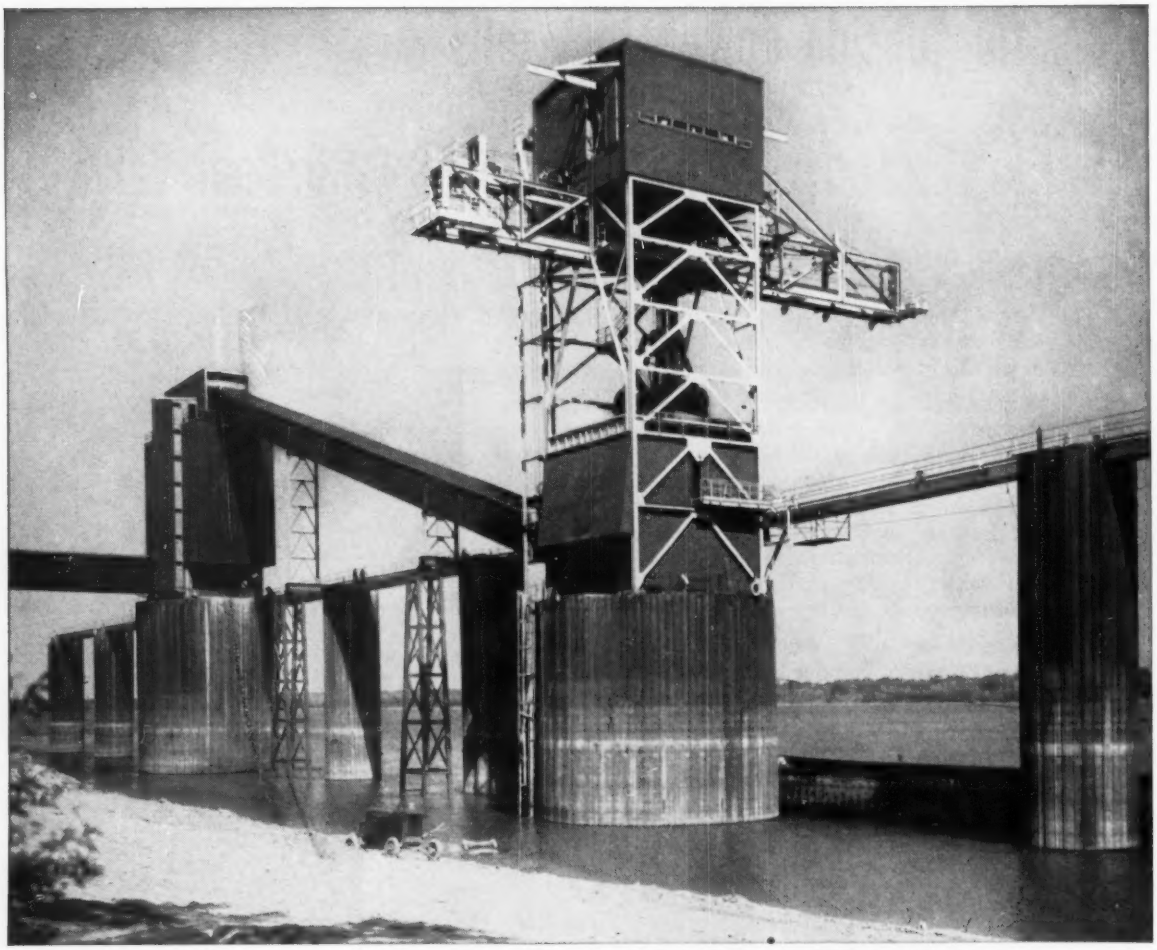
EVEN UPSIDE DOWN... IT CLOSES!

Here's proof that S-E-CO racks and pinions are *truly* self-cleaning. Valve gate closes, completely. And it opens again, all the way. If it works under these conditions, it will work even better for you.

Get the rest of the inside story on the S-E-CO Coal Valve. Send now for Bulletin 97.

Equipment Company

745-P HANNA BLDG. • CLEVELAND 15, OHIO



9-ton coal unloader, with free digging capacity of 850 tons per hour, has an average operating lift of 75 feet and travel distance of 40 feet.

Barge unloading?...WE DO THE COMPLETE JOB— unloading tower, dock and all auxiliaries

Dravo experience in the design and construction of complete bulk materials handling installations can help you lower coal handling costs materially. Take the facility shown above. The cellular steel sheet pile dock requires no maintenance, provides safe mooring for barges and supports the barge shifters, other auxiliaries and the unloading tower.

This all-welded tower has a single hoist motor and drum which perform all hoisting and lowering operations. Hoisting rope pull is equalized, and a counterweight reduces hoisting horsepower. A separate drive provides independent and positive bucket closing.

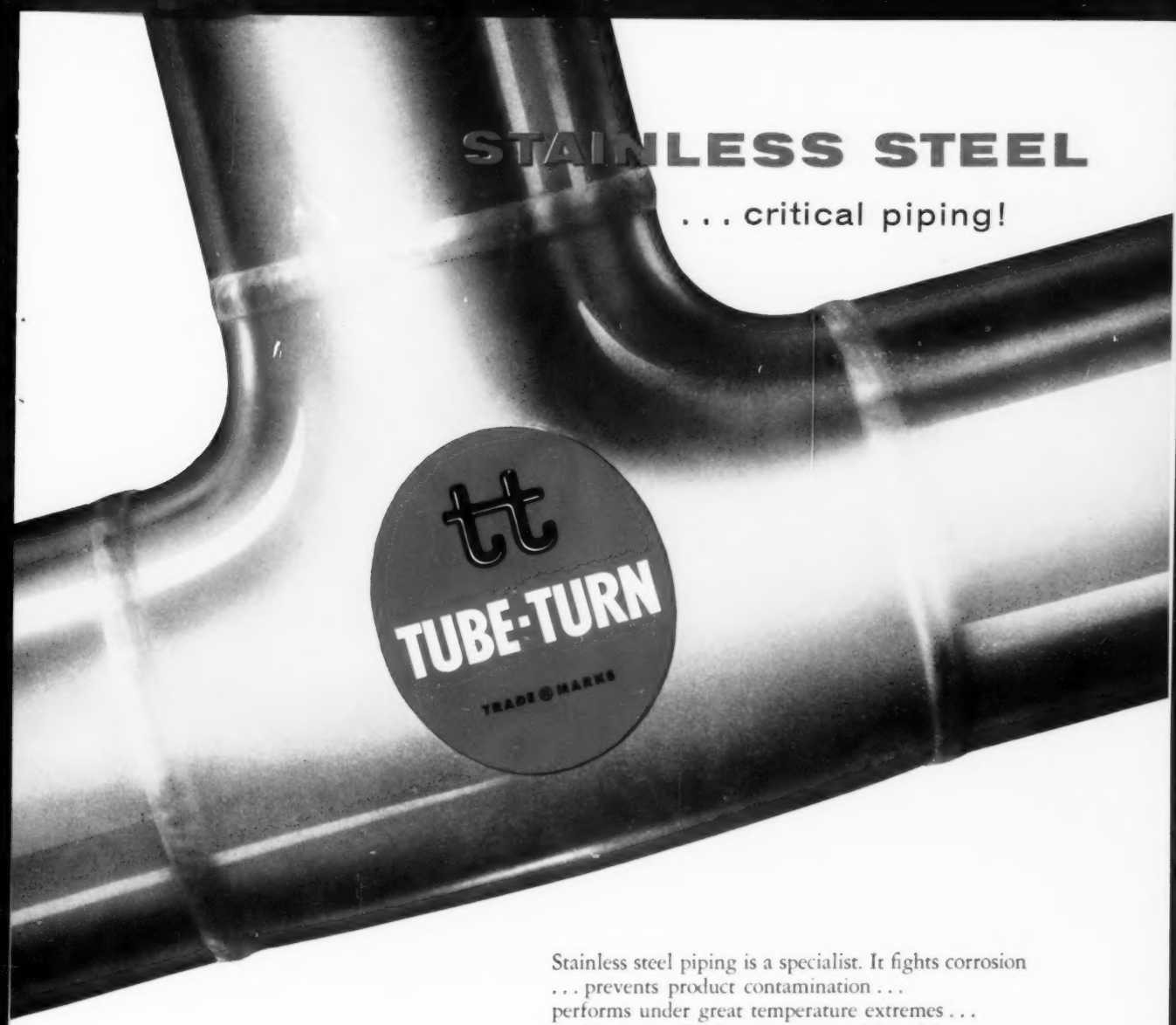
Dravo facilities provide for the design, fabrication and erection of the complete job. Tower, dock and auxiliaries are integrated into a smooth-running installation designed to operate at maximum efficiency and low cost.

Dravo heavy materials handling equipment is at work in power plants, steel mills, port docks and other materials transfer points. You can learn about Dravo's complete line of trolleys, bridges, towers and other related equipment by writing for Bulletin #225. Better still, let us arrange for your visit to actual installations. Simply call us at Pittsburgh, Spalding 1-1200, or write DRAVO CORPORATION, PITTSBURGH 25, PENNSYLVANIA.

DRAVO
CORPORATION

DRAVO

Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation



. . . a critical place to safeguard your reputation with "**TUBE-TURN**" products

Stainless steel piping is a specialist. It fights corrosion . . . prevents product contamination . . . performs under great temperature extremes . . . is able to handle dangerous materials safely. Construction and maintenance dollars, often the safety of life and property, and *your reputation* are at stake in the selection of these materials.

When you specify TUBE-TURN* Stainless Steel Fittings and Flanges, you get extra-value features and greater strength at no extra cost. Fittings are marked with *complete* identification. Production procedures and quality control assure conformity to all code requirements.

Your nearby Tube Turns' Distributor can meet *all* your needs in welding fittings and flanges *promptly*.

*"TUBE-TURN" and "tt" Reg. U. S. Pat. Off.

TUBE TURNS LOUISVILLE 1, KENTUCKY

A Division of National Cylinder Gas Company

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle

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YOUR SAFEGUARDS

You get these extra values

at no extra cost with

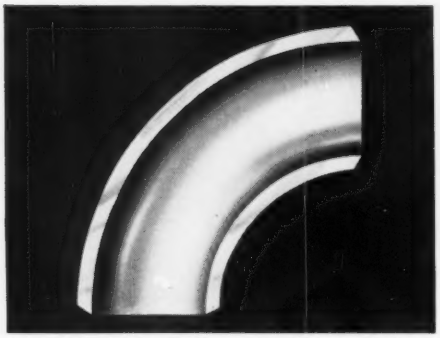
TUBE-TURN

Stainless Steel Fittings

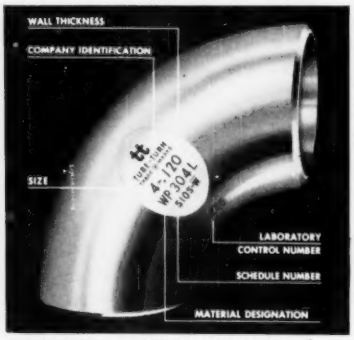
- Fittings meet *all* standard chemistry specifications
- Minimum wall thickness of elbows are at least 87½% of nominal
- All fittings meet calculated bursting pressure of matching pipe
- Qualified welders and procedures used where welding is required
- Each fitting properly solution heat-treated
- Each fitting passivated
- Special grades of stainless steel, and all other alloys available

Meet all codes: ASTM A403 (for material and manufacturing procedure); MSS SP43 and ASA B16.9 (for dimensions); and MSS SP25 (marking procedure).

TUBE-TURN Stainless Steel Elbows and Tee in a petrochemical plant.



UNIFORM WALL. Fittings meet ASA standards of 87½% of nominal thickness . . . particularly important for light wall elbows. Many conventional stainless steel elbows are as much as 30% to 40% below nominal at this point of greatest wear. All TUBE-TURN® Stainless Steel Fittings, including tees, match calculated bursting strength of the pipe.



COMPLETE IDENTIFICATION. You *know* this fitting conforms to specified quality because the material type and quality control are fully identified. Manufacturer, size, wall thickness and schedule are also marked as shown on the fitting.

CUTS PURCHASING COSTS. You can order TUBE-TURN Stainless Steel Fittings from your nearby Tube Turns' Distributor . . . on the same order as other types of welding fittings in Tube Turns' line of 12,000 products. Cuts red tape. Saves time. Photo courtesy McJunkin Corporation, Charleston, W. Va.

STAINLESS STEEL CATALOG—Complete information on properties, application, standards, welding procedure and all types of TUBE-TURN Stainless Steel Fittings and Flanges. Mail coupon for your free copy

TUBE TURNS, Dept. C-1
224 East Broadway, Louisville 1, Kentucky
Please send STAINLESS STEEL CATALOG.

Company Name_____

Company Address_____

City_____ Zone_____ State_____

Your Name_____

Position_____

Available from your nearby TUBE TURNS' Distributor

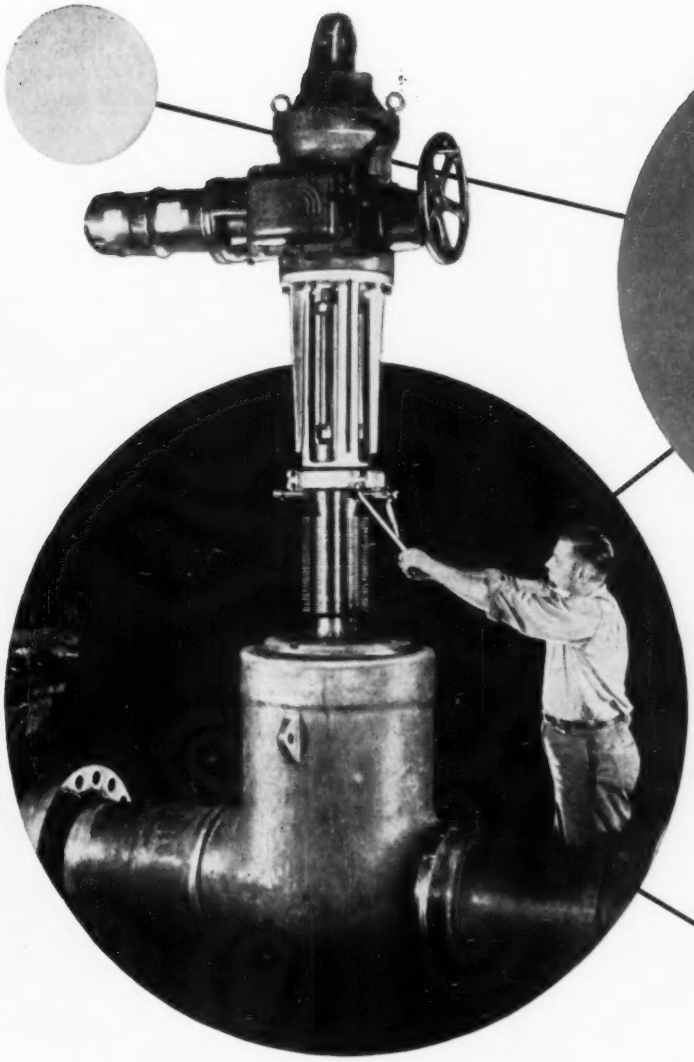
*"TUBE-TURN" and "tt" Reg. U.S. Pat. Off.

TUBE TURNS

A DIVISION OF NATIONAL CYLINDER GAS COMPANY

LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Detroit • Atlanta • New Orleans • Houston • Midland • Dallas • Tulsa • Kansas City • Denver • Los Angeles • San Francisco • Seattle. **IN CANADA:** Tube Turns of Canada Ltd., Ridgetown, Ontario • Toronto, Ontario • Edmonton, Alberta • Montreal, Quebec • Vancouver, British Columbia.



in one of first land-based ATOMIC POWER PLANTS

LimiTorque

will operate special 18″ Flow Control Valves

Shown above is the prototype of the special 18″ Main Coolant Valves used at the Shippingport, Pennsylvania Plant of the Duquesne Power & Light Co. There are eight similar Crane Stainless Steel Parallel disc Gate Valves used on the Coolant lines in a pressurized water reactor system; and several will be opened and closed electrically by LIMITORQUE "push-button" Valve Operators. These valves are designed to seat and back-seat at pre-determined fixed loading. Special dial indicators are provided for continuous observation of seat-loading.

. . . Many other critical valves in this plant will be operated by standard Limitorque Valve Controls.

If standard Limitorque designs will not fulfill a special valve requirement, Limitorque engineers are prepared to solve your most difficult problems of valve operation or flow control.

Far more Valves of all types are "push-button" operated by Limitorque than all other makes.

Write on your business letterhead for catalog L-550, which fully illustrates and describes Limitorque.

LimiTorque®

PHILADELPHIA GEAR WORKS, INC.
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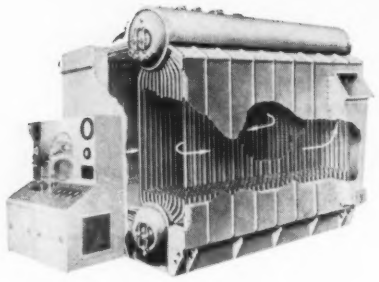
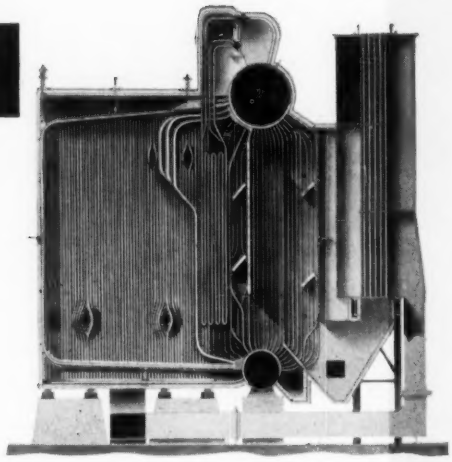
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

Limitorque Corporation • Philadelphia

OIL AND GAS FIRED BOILERS
(standardized designs)



C-E Package Boiler, Type VP – Completely shop assembled . . . available in 14 sizes from 4,000 to 50,000 lb of steam per hr capacity . . . pressures to 500 psi. Available with integral console control panel. This unit contains more water-cooled area per cubic foot of furnace volume than any other boiler of its size and type.



C-E Vertical-Unit Boiler, Type VU-55 – Available in six sizes . . . capacities from 50,000 to 120,000 lb of steam per hour . . . designed for two pressure ranges, 250 psi and 500 psi, and total steam temperatures up to 750 F. Equipped with tangential burners. 60-inch steam drum assures generous water capacity and steam reservoir space. Tangent tube waterwalls offer complete furnace protection, minimizing maintenance.

MODERN INDUSTRIAL

C-E offers the most advanced steam generating in any size . . . for any fuel . . . with any method

All the designs pictured here have something in common. All are evolved from a basic design concept – a 2-drum, vertical boiler with fully water-cooled furnace in front of the boiler proper – a design which Combustion Engineering originated more than 30 years ago and which has enjoyed the widest acceptance.

All are fully integrated designs comprising boiler, furnace, fuel-burning and, where required, superheat and heat-recovery equipment, coordinated into a smoothly functioning unit.

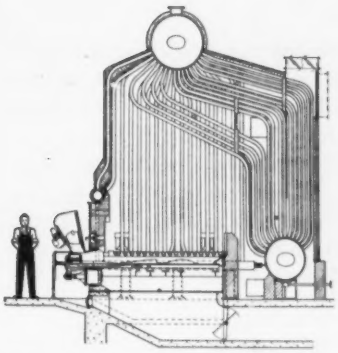
All have benefited from C-E's experience in meeting the most exacting standards in steam generation – those of the electric utility industry for which C-E is currently designing and building boilers which will set tomorrow's standards of capacity, pressure and temperature.

All have demonstrated – in many installations – high standards of performance . . . economy, reliability and suitability for the particular fuel and operating conditions for which they were selected.

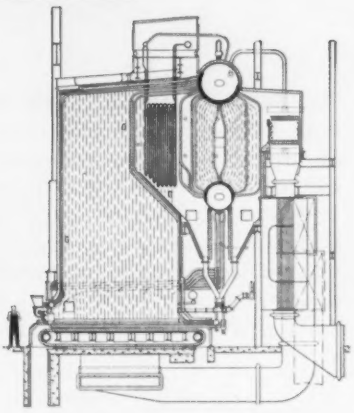
So – no matter what combination of conditions prevail at your plant, Combustion has a boiler unit that can meet your requirement, exactly – and economically. We'd like to discuss it with you and your consultants.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

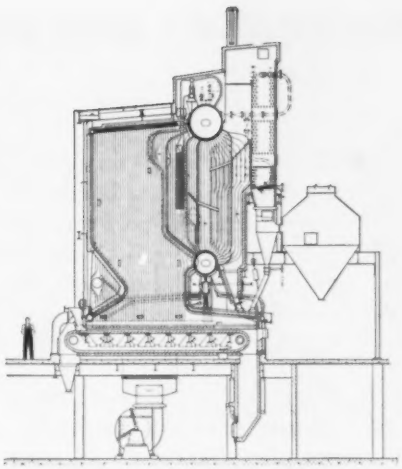
STOKER-FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-10 – fired by a C-E Underfeed Stoker, Type E – VU-10 Boilers are available for capacities from 10,000 to 60,000 lb of steam per hr with pressures to 475 psi; superheat to 200 F in larger sizes. Also can be equipped with C-E Spreader Stokers, dump grate type.



C-E Vertical-Unit Boiler, Type VU-40 – fired by C-E Spreader Stoker, continuous discharge type – A baffleless boiler with capacities ranging up to about 300,000 lb of steam per hr, with pressures to 1,200 psi; temperatures to 950 F.

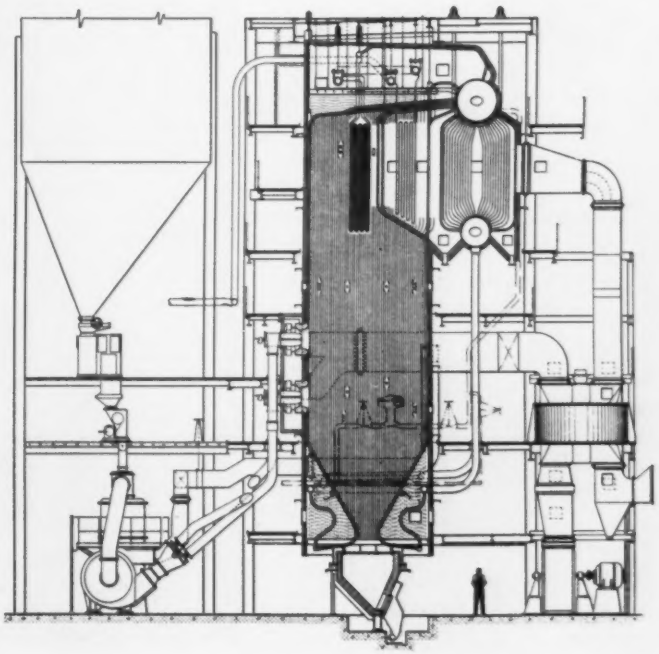


C-E Vertical-Unit Boiler, Type VU-50 – fired by C-E Traveling Grate Stoker – Units of this design are suitable for capacities up to about 150,000 lb of steam per hr; pressures to 1,200 psi; temperatures to 950 F.

BOILERS

equipment of firing

PULVERIZED COAL FIRED BOILERS*



C-E Vertical-Unit Boiler, Type VU-40 – using C-E Raymond Bowl Mills and Horizontal Burners – Capacities up to 600,000 lb of steam per hr, pressures to 1,200 psi, temperatures to 950 F.

These drawings are a few examples of the many units available for coal firing: all are readily adaptable to oil or gas firing.

COMBUSTION ENGINEERING

C-E

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd.

C-139

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

"BUFFALO" MATCHES FAN TO REQUIREMENTS

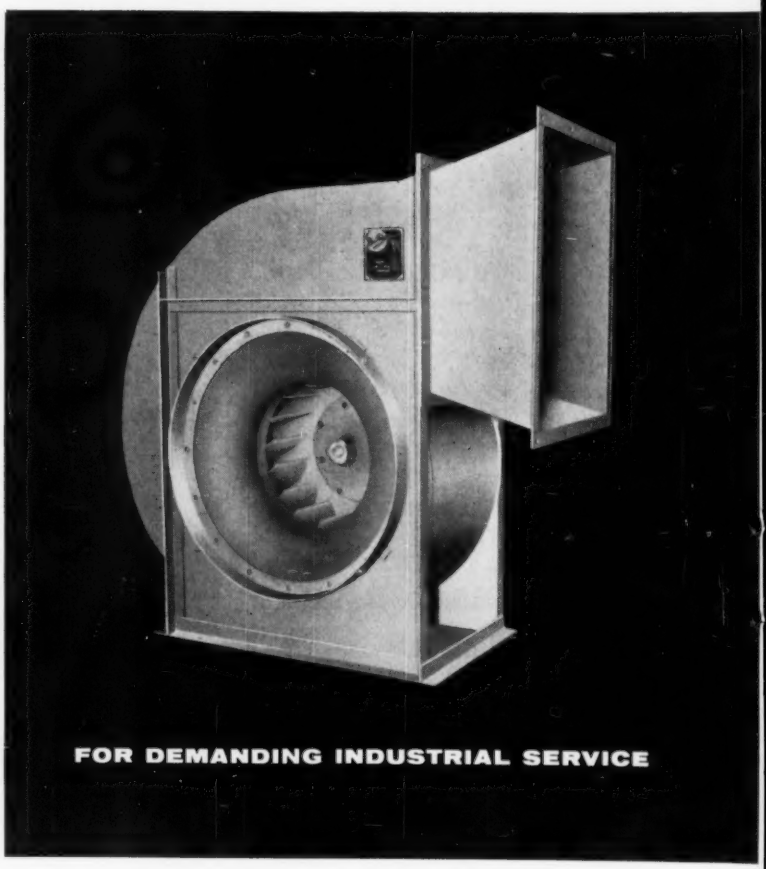
● "Buffalo" believes in designing specific *separate* fans to meet different performance requirements — not merely offering variations of the same basic fan design to meet varying needs.

Shown on this page are three of the many fans in the complete "Buffalo" line engineered to cover every type of heavy-duty industrial and power plant application.

These three "Buffalo" Fans — the "CR", the "BL" and the "BLH" — are designed to fulfill your central system or mechanical draft requirements with the highest possible efficiency, dependability and overall economy. Behind these fans are the 81 years of "Buffalo" research and engineering experience, plus up-to-the-minute design improvements, to insure a long life of useful service.

Whatever your requirements for heavy-duty air moving, whether for mechanical draft or ventilating purposes, there's one *right* "Buffalo" fan to do your job best. For expert engineering assistance, contact your nearest "Buffalo" Representative — or write for the Bulletins covering your needs.

The "Buffalo" Type "CR" Radial Blade Fan was specially designed for heavy-duty industrial and power plant service. It has gained wide acceptance for induced draft applications, particularly with stoker-fired or pulverized coal boilers. It is extensively used throughout the steel, cement, mining and many other industries. The rugged construction and wear-resistant qualities of the "CR" assure a long life of maintenance-free service. Its high capacity, high pressure performance may enable you to utilize a smaller, less expensive fan for many direct-connected requirements. For full information on the "Buffalo" Type "CR" Fan, write for Bulletin FD-205.



Every "Buffalo" Fan features the famous "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

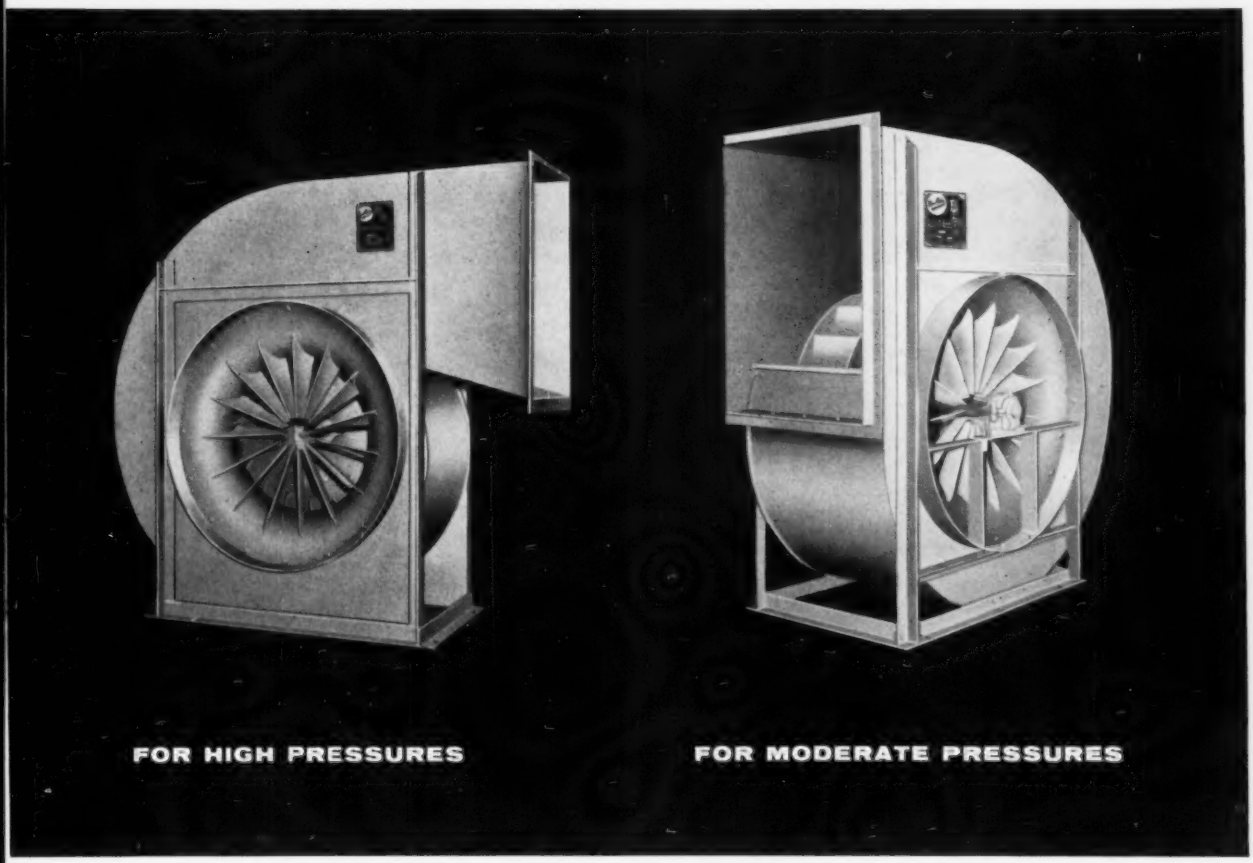
"Buffalo"

CANADIAN

EXACTLY—FOR ALL HEAVY-DUTY AIR MOVING

The "Buffalo" Type "BLH" Fan is unsurpassed for Classes III and IV mechanical draft and ventilating service. A combination of "Buffalo" engineering features insures a new high in performance over a broad efficiency range. The uniquely-designed housing provides smooth, streamlined air flow, extremely high static conversion and excellent pressure distribution at the fan outlet. Distortion-free inlet and smooth, backward-curved wheel blades also contribute to the "BLH" Fan's highly efficient performance and exceptionally stable operation over the entire range from free delivery to shut-off. A long, trouble-free life is assured by the traditionally sturdy "Buffalo" construction features. Write today for Bulletin F-200.

The "Buffalo" Type "BL" Fan is ideally suited for most conditions in Classes I and II mechanical draft service, and central system ventilating applications. High static efficiencies and minimum noise levels result from the unique "Buffalo" all-streamlined design of inlet, rotor and housing. The fixed inlet guide vanes and deep drawn, smoothly-curved inlet bell properly distributes the air flow into the wheel, minimizing inlet shock loss. Backward-curved blades provide the desirable non-overloading horsepower characteristic. Long-lived dependability is insured by such rugged construction features as die-formed and welded components. Write for Bulletin F-102 today.



FOR HIGH PRESSURES

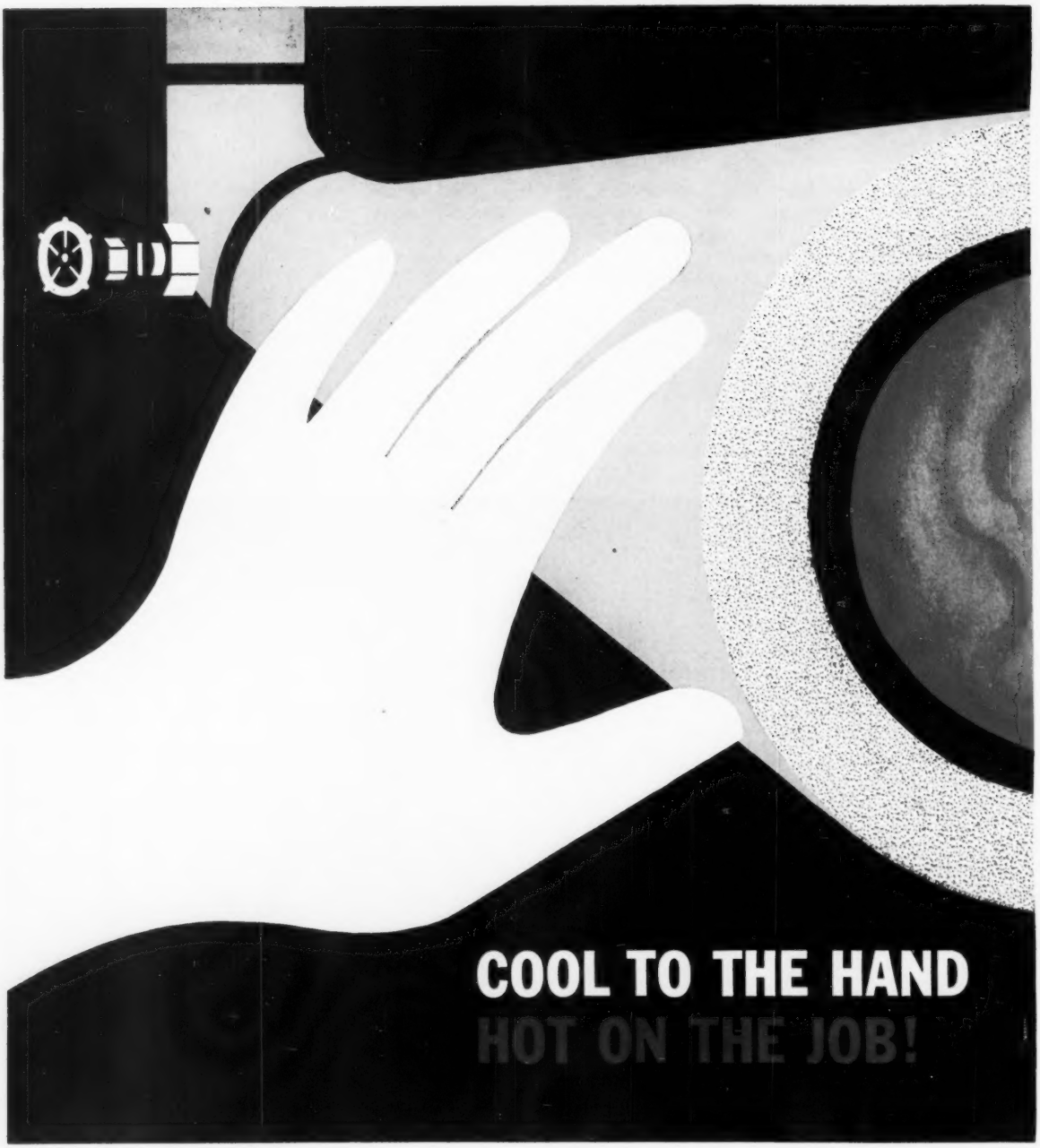
FOR MODERATE PRESSURES

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

BLOWER & FORGE CO., LTD., KITCHENER, ONTARIO

VENTILATING
AIR CLEANING
AIR TEMPERING
INDUCED DRAFT
EXHAUSTING
FORCED DRAFT
COOLING
HEATING
PRESSURE BLOWING



K&M HIGH-PRESSURE INSULATIONS

Here's how to keep fuel costs at rockbottom . . . and make them stay there for the life of your equipment: K&M High-Pressure Insulations. Even severe operating conditions can't interfere with their insulating efficiency. They handle temperatures up to 1900°F. Come in a variety of sizes and thicknesses. In pipe or block insulation.

Write to us today for a free brochure. It shows how you can insure more precise process control . . . greater heat efficiency . . . with K&M.

K·M
BEST IN ASBESTOS

KEASBEY & MATTISON
COMPANY • AMBLER • PENNA.

GRACE CHEMICAL CO., DIVISION OF W. R. GRACE & CO.

At its Memphis plant, Grace Chemical produces 300 tons of anhydrous ammonia per day. Three 4,000-h.p. compressors are the heart of this operation, each handling 3 different gases under varying intake and discharge conditions.

Fire-resistant PYDRAUL AC protects huge compressor operations at Grace Chemical Co.

Turning out 300 tons of anhydrous ammonia per day depends on reliable and SAFE performance of the compressors. That's why Grace engineers at Memphis take every precaution to insure continuous operation. They choose fire-resistant Pydraul AC to lubricate air compressors, minimize carbon deposits and thus reduce fire dangers.

Compressor fire and explosion dangers lurk in flammable lubricants and their residues deposited in compressed air cylinders and piping. Eliminate these dangers now in your compressors, any size, any make.

Conversion is easy . . . essentially, just drain your flammable fluid and replace with fire-resistant Pydraul AC.

Send the coupon for your copy of the new Pydraul AC booklet . . . for the answers to your compressor lubricant problems.

Organic Chemicals Division

MONSANTO CHEMICAL COMPANY

Dept. PO-1

St. Louis 24, Missouri

Pydraul: Reg. U.S. Trademark

Monsanto®

WHERE CREATIVE CHEMISTRY WORKS WONDERS FOR YOU

Please send me the PYDRAUL AC booklet

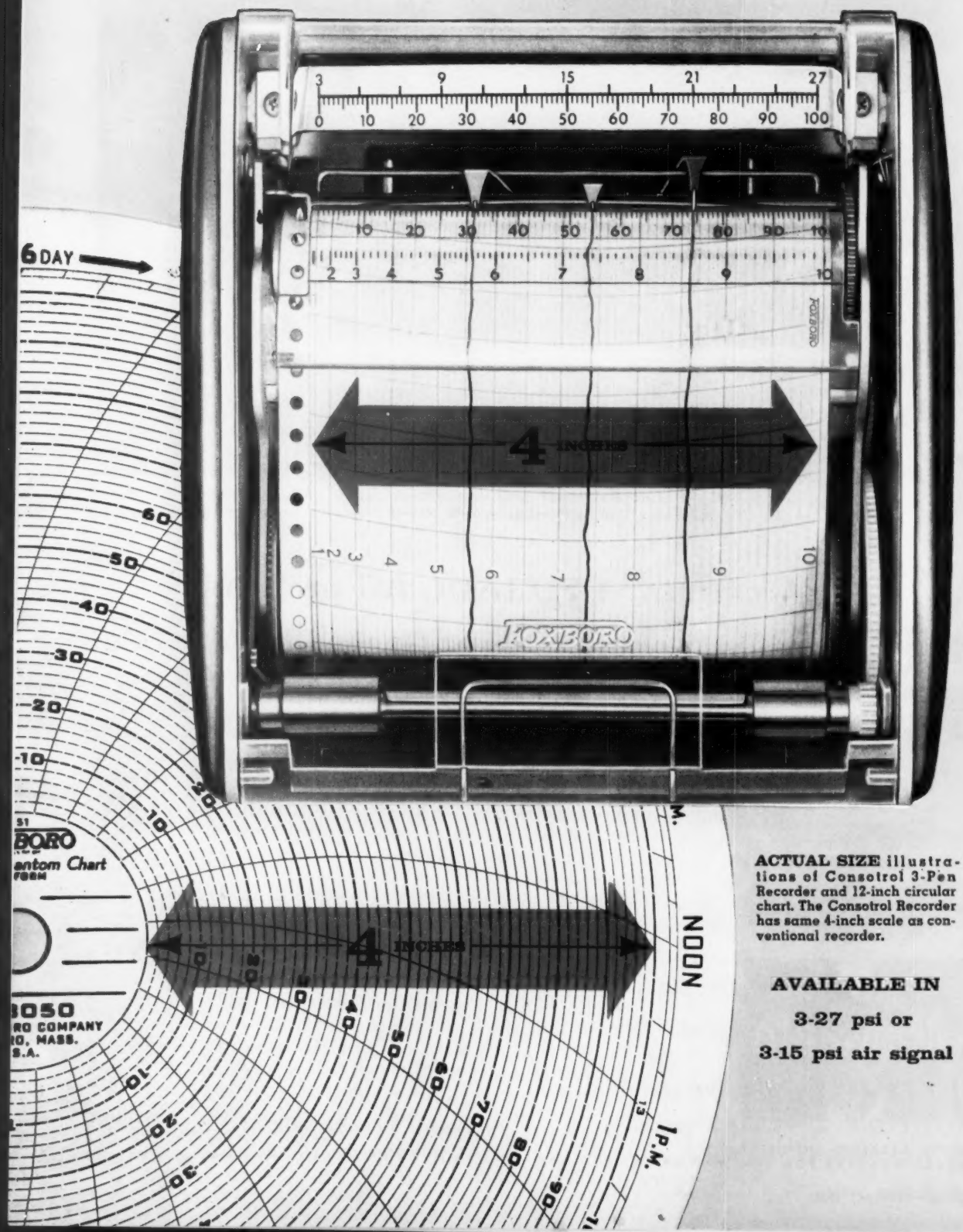
Name..... Title.....

Firm.....

Address.....

City..... State.....

FOXBORO "small-case"



ACTUAL SIZE illustrations of Consotrol 3-Pen Recorder and 12-inch circular chart. The Consotrol Recorder has same 4-inch scale as conventional recorder.

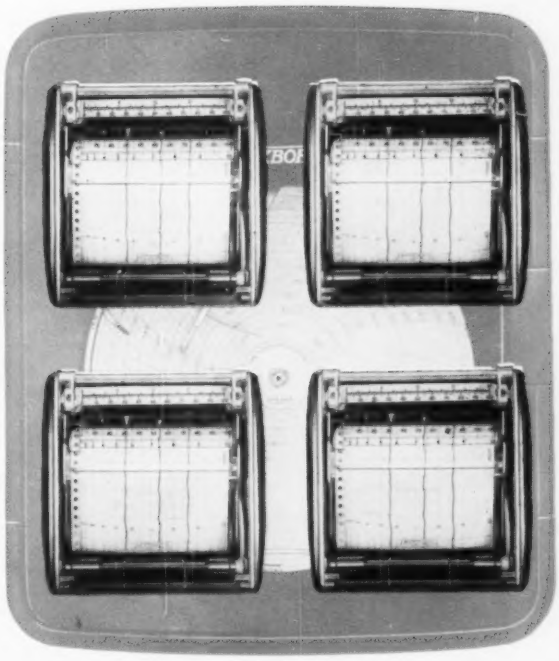
AVAILABLE IN

3-27 psi or

3-15 psi air signal

Recorders save 75% in panel space...

...without sacrifice of FULL-SCALE readability



FOUR WHERE ONE USED TO GO — providing up to 12 full-size, continuous records.

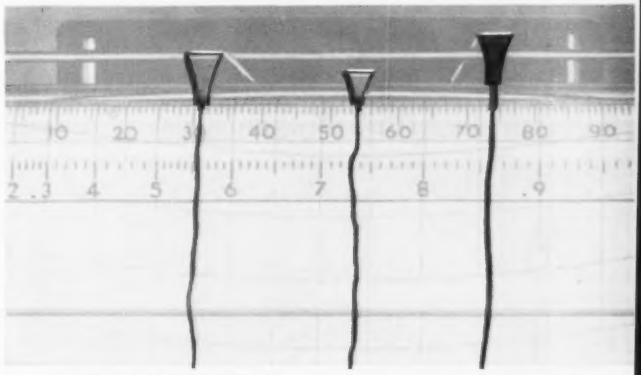
Think of it! Four compact Consotrol* Recorders actually occupy less panel space than one conventional size recorder. Yet there's no sacrifice in readability, for Consotrol charts have the same length scale as standard 12" recorders.

And 75% panel space savings are only the beginning. Consotrol Recorders are now available in 3 - 27 psi models, (as well as 3 - 15 psi) for greater flexibility in power plant trend-recording.

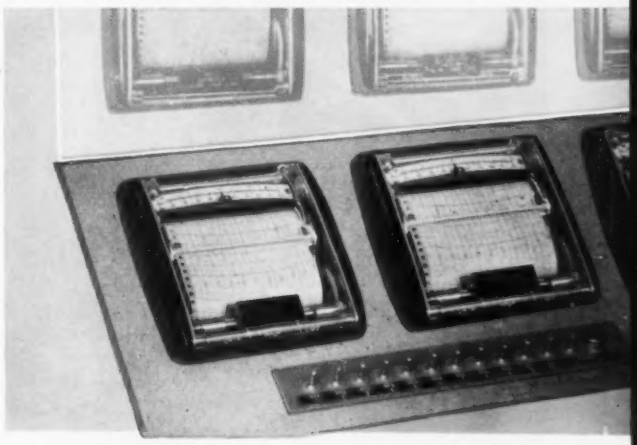
They're simple to maintain, too. On all recorders (one, two, or three pen), all calibration adjustments are made from the front; charts replaced at 30-day intervals; re-inking done just twice a year. Accurate and dependable, Consotrol Recorders are ideal for recording trends of boiler feed water, steam-air and fuel-air flows, as well as steam pressure, temperature and other variables.

Get complete details on Consotrol "small-case" Recorders. Write for Bulletin 13-18A. **The Foxboro Company, 682 Neponset Ave., Foxboro, Mass.**

Reg. U. S. Pat. Off.



3-PEN RECORDING — 3 continuous records can be simultaneously recorded on one Consotrol chart. Related measurements can be grouped for quick comparison — valuable panel space saved.

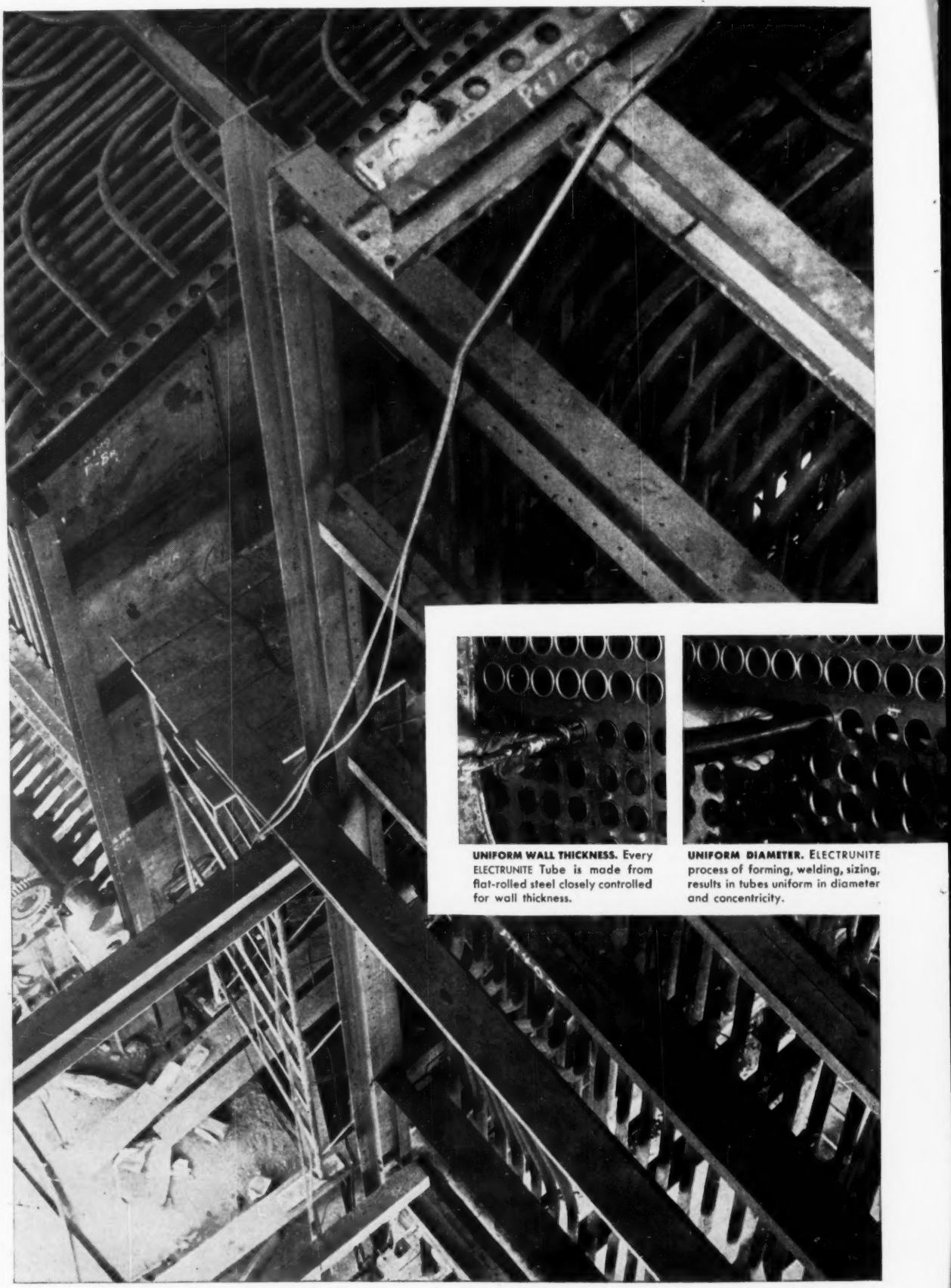


ANGLE MOUNTING — One- and two-pen Consotrol Recorders may be panel-mounted as much as 75° from the vertical. A whole "extra" row of instruments can be read without stooping.

FOXBORO

REG. U.S PAT. OFF.

CONSOTROL RECORDERS



UNIFORM WALL THICKNESS. Every ELECTRUNITE Tube is made from flat-rolled steel closely controlled for wall thickness.

UNIFORM DIAMETER. ELECTRUNITE process of forming, welding, sizing, results in tubes uniform in diameter and concentricity.

Bird's-Eye View of Uniformity...

Republic ELECTRUNITE Boiler Tubing

Installed at LeTourneau-Westinghouse Plant

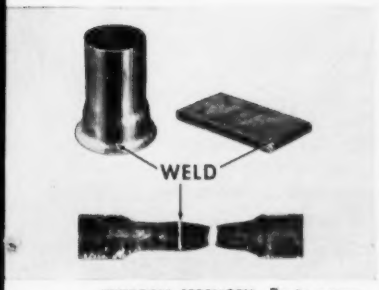
Power, key to productivity, demands a power plant designed and engineered to meet critical requirements and severe operating conditions of service. That is why Republic ELECTRUNITE® Boiler Tubes were specified for the new LeTourneau-Westinghouse Company installation at Peoria, Illinois.

This new power plant, furnished by the Erie City Iron Works Company, Erie, Pennsylvania, has a designed capacity of 40,000 pounds of steam per hour and operates at 125 psi.

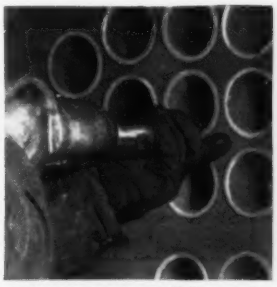
Each length of Republic ELECTRUNITE Boiler Tubing is hydrostatically or electronically tested to conform with the applicable ASTM specification and the ASME Boiler and Pressure Vessel Code, as well as local, state and boiler-insurance requirements. And stress values for Republic ELECTRUNITE tubes are the same as those for tubes made by other processes for temperatures up to 850°F. ELECTRUNITE is available for pressures over 2000 psi. in various sizes and wall thicknesses.

Made of highest quality flat-rolled open-hearth steel produced in Republic's own mills, carefully controlled every step of the way, are reasons why more and more Republic ELECTRUNITE is specified by designers, engineers, and operators for vital steam generating units operating in every industry and community field.

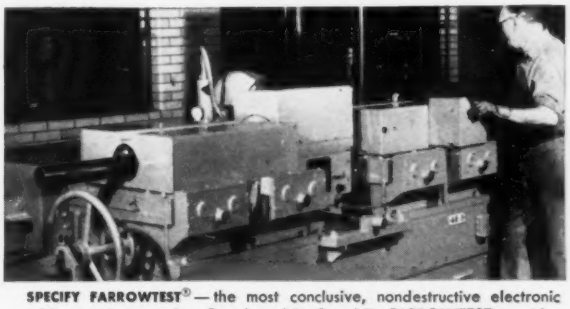
For additional Republic ELECTRUNITE Boiler, Condenser, or Heat Exchanger Tubing facts, call your Republic representative or send coupon today.



UNIFORM STRENGTH. Tests prove ELECTRUNITE process results in a tube with a weld as strong or stronger than the base metal.



UNIFORM DUCTILITY. Full normalizing, plus characteristics of Uniform Wall Thickness and Diameter, assures easy workability.



SPECIFY FARROWTEST® — the most conclusive, nondestructive electronic tubing test in use today. Developed by Republic, FARROWTEST provides detector coils that can electronically spot irregularities in tube walls which would be hidden from routine test procedures. Send for brochure today.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
DEPT. C-5159
221 EAST 131ST STREET • CLEVELAND 8, OHIO

Please send the following literature:

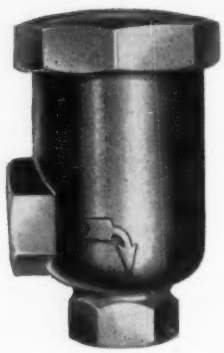
☐ ELECTRUNITE Boiler Tubes
☐ ELECTRUNITE Heat Exchanger Tubing
☐ Carbon ☐ Stainless ☐ FARROWTEST Brochure

Name_____ Title_____
Firm_____
Address_____
City_____ Zone____ State_____

need
steam traps?

name the way you want them!

TYPE A



TYPE D

TYPE C

Nicholson can supply your steam traps, exactly as you want them . . . for any service, any condition. Name the size, material, pressure, capacity you need. Types A, D, C are the ones you'll most likely use. Make your selection.

Sizes: A—from ¼″ to 1″. D—from ¼″ to ¾″. C—from ½″ to 2″.

Materials: Cast Iron and Cast Steel.

Pressures: A and D—Vacuum to 200 lbs. C—Vacuum to 300 lbs.

Capacities: From two to six times greater orifice area and capacity than other traps of comparable size.

Why wonder about your steam traps . . . when you can get Nicholsons exactly as you need them for your own applications. Nicholson traps are simple in design, have only one moving part . . . a valve that discharges condensate and prevents steam loss.

You get faster warmup, with high air-venting capacity. You eliminate costly leakage, with a powerful shut-tight valve action. You get a trap that's service-tested, when you specify Nicholson. You can try one . . . without obligation! W. H. Nicholson and Company, 12 Oregon St., Wilkes-Barre, Pa. Sales and engineering offices in 98 principal cities.

NICHOLSON
of Wilkes-Barre

For pure, rust-free hot water, specify copper-lined heaters

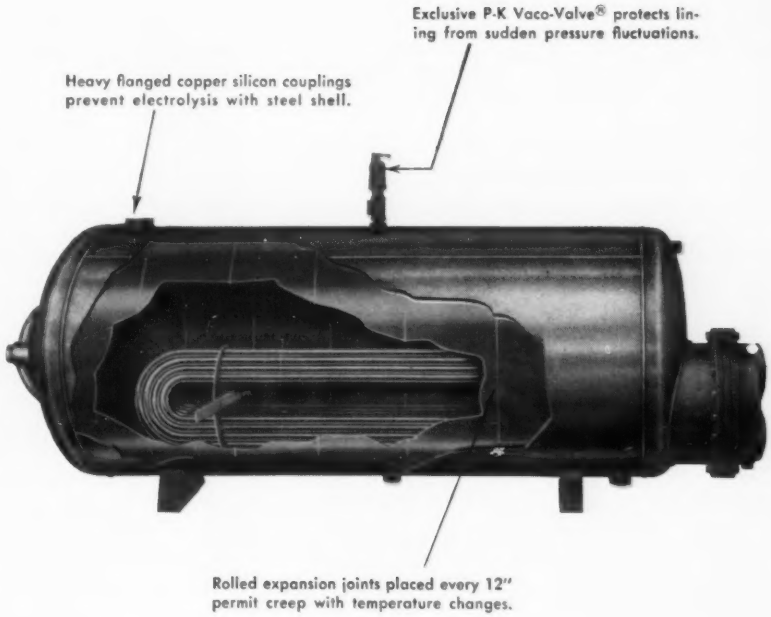
For guaranteed, trouble-free performance, specify P-K COPPER-LINED heaters

Copper-lined storage heaters assure a plentiful, pure, rust-free hot water supply. But a copper-lined water heater must also have the design and engineering features that assure long life and trouble-free service—and that's why so many engineers specify P-K Copper-lined Storage Water Heaters.

The P-K Copper-lined Heater is, in effect, two heaters in one. It is a copper shell built inside, and reinforced by, a heavy steel shell . . . combining the non-corrosive qualities of copper with the superior strength of steel. And wherever copper meets steel, the joint is protected against electrolysis by spinning copper over the tube sheet openings, or using copper silicon fittings for outside connections. Moreover, P-K testing procedures insure top operating efficiency—for every P-K Heater undergoes exacting hydrostatic and pneumatic tests that search out areas of possible failure.

In the past 40 years P-K has built more copper-lined heaters than any other fabricator. Thousands of them are installed from coast to coast, supplying users with an unfailing source of rust-free hot water and requiring only routine maintenance—proof of the soundness of P-K design and fabrication.

Put this experience to work for you by specifying P-K when you buy copper-lined hot water storage heaters. Meanwhile, get complete construction details, heating capacities, engineering and installation data by writing for P-K Data File #16 on copper-lined storage water heaters to The Patterson-Kelley Co., Inc., 2502 Warren Street, East Stroudsburg, Pa.


Exclusive P-K Vaco-Valve® protects lining from sudden pressure fluctuations.
Heavy flanged copper silicon couplings prevent electrolysis with steel shell.
Rolled expansion joints placed every 12" permit creep with temperature changes.

Patterson Kelley

3

Storage Water Heaters • Instantaneous Heaters • Convertors • Fuel Oil Heaters • Freon Chillers and Condensers

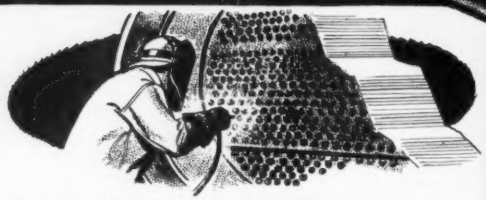
POWER POINTERS

IT'S CURTAINS

FOR FLUE-GAS CONTROL PROBLEMS

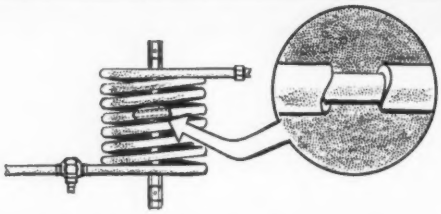
...0.005-INCH INCONEL ALLOY CURTAINS

FLUE GASES...UP TO 800°F...WERE TOO HOT FOR REGULAR ASBESTOS DAMPER CURTAINS IN ONE ELECTRIC COMPANY BOILER. SO THE CURTAIN MANUFACTURER DESIGNED ONE MADE OF METAL. IT HAS THE SAME WINDOW-SHADE ACTION; THE SAME FLEXIBILITY. BUT IT'S MADE OF 0.005-INCH THICK INCONEL* NICKEL-CHROMIUM ALLOY SHEET. THREE YEARS OF ASH-LADEN STACK GASES HAVEN'T CORRODED OR WORN THE INCONEL CURTAIN TO ANY NOTICEABLE DEGREE.



New all-welded high-pressure feedwater heater

THIS NEW, ALL-WELDED FEEDWATER HEATER ENCOUNTERS PRESSURES TO 3600 PSI...INLET STEAM TO 790°F. TO INSURE RELIABLE OPERATION, "140" MONEL* NICKEL-COPPER ELECTRODES WERE USED TO WELD ITS FOOT-THICK STEEL TUBE SHEETS TO COPPER-NICKEL TUBES. THE HIGH NICKEL CONTENT OF THIS ELECTRODE MAKES POSSIBLE DUCTILE, NON-POROUS WELDS THAT STAY STRONG UNDER SEVERE CONDITIONS.



NEW INNER TUBE FOR STEAM SAMPLER GIVES EXTRA "MILEAGE"

AT A MID-WESTERN POWER PLANT, STRESS-CORROSION CRACKING RUINED INNER TUBES OF HIGH-TEMPERATURE STEAM SAMPLER COILS IN SIX MONTHS OR LESS. A SWITCH TO INCONEL ALLOY HAS TRIPLED INNER TUBE "MILEAGE" EVEN THOUGH THE SAME THERMAL SHOCK AND CORROSIVE CONDITIONS EXIST.

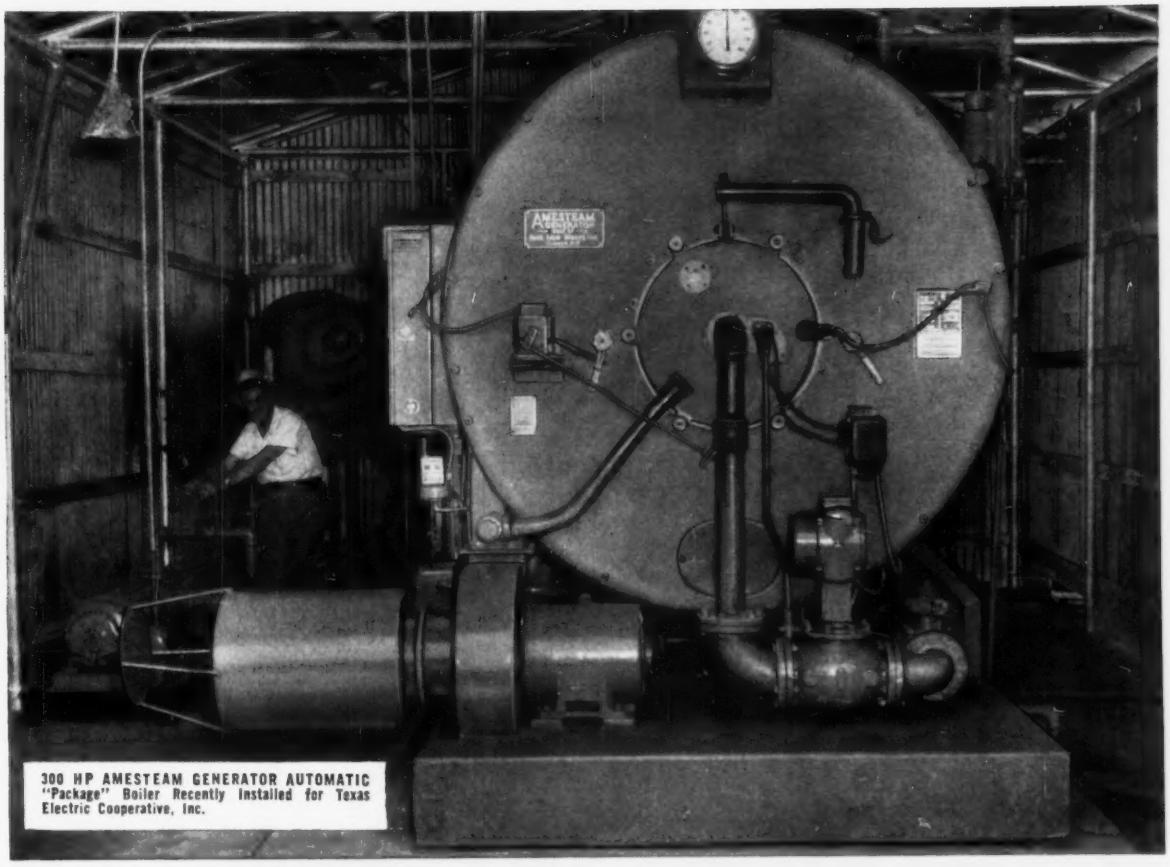
WHAT'S YOUR METAL PROBLEM?

MAYBE AN INCO NICKEL ALLOY CAN REINFORCE YOUR INGENUITY AND LEAD TO A QUICK SOLUTION. TO EXPLORE THE POSSIBILITIES, WRITE FOR INCO BULLETINS COVERING THE ENGINEERING PROPERTIES OF INCONEL AND INCONEL 'X' ALLOYS AND MONEL AND 'K' MONEL ALLOYS.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

*Registered Trademark



300 HP AMESTEAM GENERATOR AUTOMATIC "Package" Boiler Recently Installed for Texas Electric Cooperative, Inc.

TEXAS ELECTRIC COOPERATIVE, INC.

Cuts Fuel Consumption Over 36%
Saves Over $15,000 per year
... with AMESTEAM GENERATOR

We Quote the Money-Saving Facts:

"We were very pleased when we replaced two gas-fired boilers in our presssure testing plant with one new 300 HP AMESTEAM GENERATOR Automatic "Package" Boiler. The new Ames unit has reduced our fuel costs alone by 38% ... a saving of *$7,800 per year.*

"Because our new AMESTEAM GENERATOR is entirely automatic, three firemen are now transferred to other duties. This results in an additional saving of *$7,200 per year.*

"This total saving of *$15,000 per year* does not include the considerable savings in maintenance costs. On top of this, the new Ames installation increases our production potential by 20% to 30% ... with much higher quality steam."

We at Ames continually receive letters like this from the enthusiastic users of AMESTEAM GENERATORS. Ames customers are *satisfied* customers. They know that when they buy AMESTEAM GENERATORS, they buy LOWER-COST STEAM!

What's **Your** Steam Problem?

If you need 10 to 600 HP and want the kind of space-saving, trouble-free service enjoyed by satisfied users of AMESTEAM GENERATORS, contact your nearby AMESTEAM Dealer or write for our Catalog.

AMES IRON WORKS INC.
BOX H-28, OSWEGO, N. Y.

AMES IRON WORKS
BOX H-28, OSWEGO, N. Y.

Gentlemen:

Please send me further information on AMESTEAM GENERATORS and name of nearest representative.

NAME .....

COMPANY .....

ADDRESS .....

JENKINS PRACTICAL PIPING LAYOUTS

81

How to plan piping connections for

A CARBONATED SOFT DRINK BOTTLING PLANT

Preparation and bottling of soft drinks requires a supply of treated water, free from alkalies, chlorine or other minerals. This water is used to dilute concentrated flavors in the mixing tank, making the syrup which is introduced into bottles or cans by the syruper. Another operation carbonates the water and feeds it into bottles or cans as the second ingredient.

This layout for a carbonated soft drink bottling plant also may be used for a "pop" *canning* plant, by changing the connections out of the three fillers.

The water treatment system depends upon the chemical analysis of local water, but the one included here is typical. Bottles (or cans) are first filled with syrup, which has been prepared by mixing flavor, liquid sugar and treated water in the mixing tank. They are then filled with carbonated water and, just before closure, injected with carbon dioxide gas to eliminate air.

Water treatment lines are red brass or copper with bronze valves and bronze-fitted pumps. The chemical line is controlled with all-iron valves to minimize effects of alkali corrosion. Liquid sugar and flavor lines are stainless steel pipe or tubing with stainless steel valves.

Either the Jenkins Fig. 1317-A Globe Valve or Fig. 1313 Twin Bolt Body Globe Valve is recommended where frequent dismantling is necessary and tightness essential. The twin bolt type is shown in the layout. Jenkins Fig. 1317-A, however, is a sturdily constructed globe valve with a multiple bolted body-bonnet joint which assures absolute tightness yet permits easy dismantling for cleaning or renewal of parts.

Consultation with accredited piping engineers and contractors is recommended when planning any piping system. To save time, to simplify planning, to get all the advantages of proved "extra value" design, specify Jenkins Valves for every service. Jenkins Bros., 100 Park Ave., New York 17.

Fig. 1317-A
Stainless Steel
Bolted Bonnet
GLOBE VALVE
O. S. & Y.

Fig. 1313
Stainless Steel
Twin Bolted Bonnet
GLOBE VALVE
O. S. & Y.

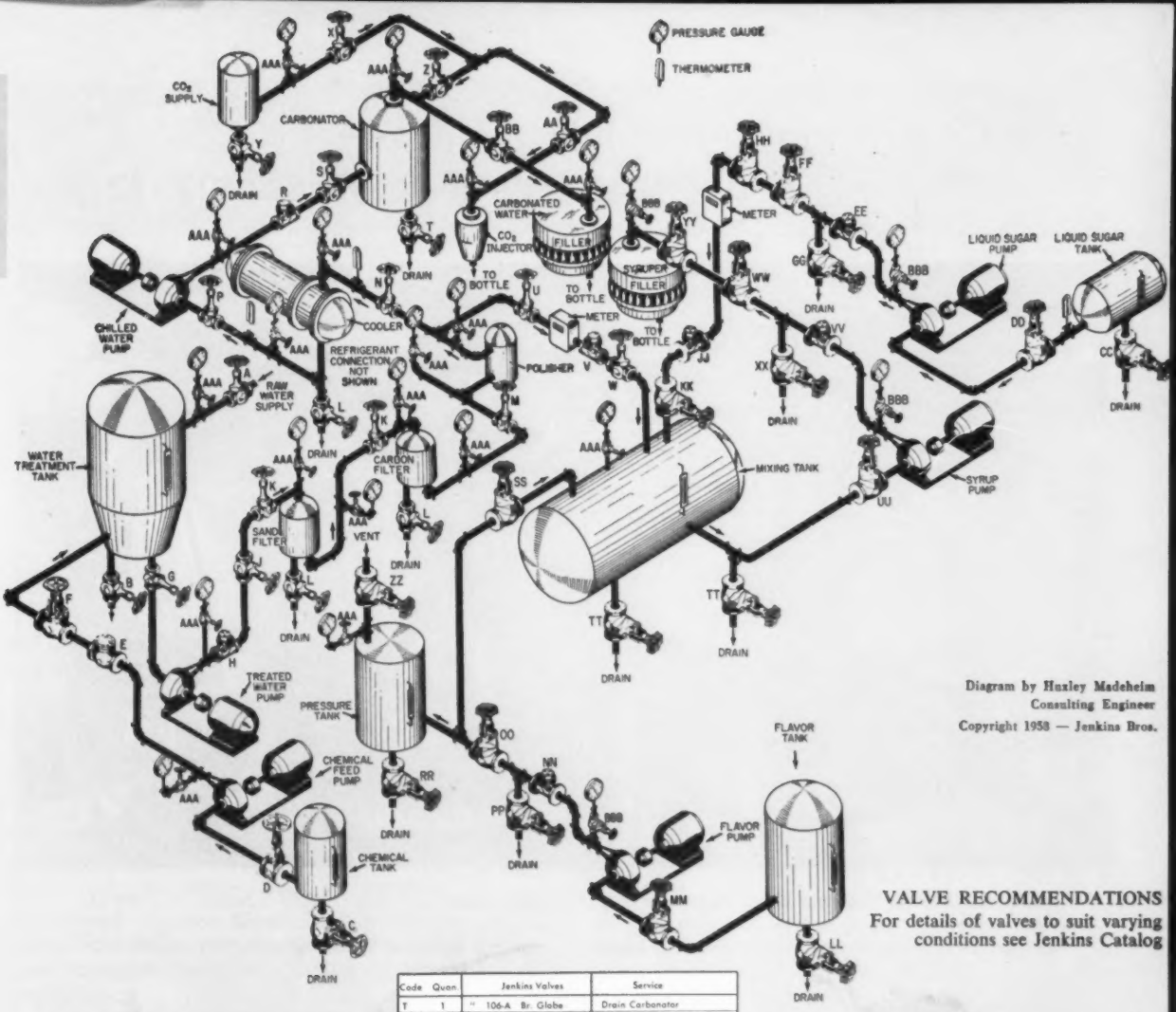


Diagram by Huxley Madeheim
Consulting Engineer

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VALVE RECOMMENDATIONS

For details of valves to suit varying conditions see Jenkins Catalog

Code	Quan.	Jenkins Valves	Service
A	1	Fig. 106-A Br. Globe	Control Raw Water Supply
B	1	" 106-A Br. Globe	Drain Water Treatment Tank
C	1	" 81 All Iron Globe	Drain Chemical Tank
D	1	" 100-A All Iron Gate	Shutoff Chemical Feed Pump
E	1	" 83 All Iron Sw. Chk.	Prevent Backflow into Chemical Feed Pump
F	1	" 81 All Iron Globe	Control Chemical Feed Pump
G	1	" 47-U Br. Gate	Shutoff Treated Water Pump
H	1	" 92-A Br. Sw. Chk.	Prevent Backflow Through Treated Water Pump
J	1	" 106-A Br. Globe	Control Treated Water Pump
K	2	" 47-U Br. Gate	Shutoff Filter Feed
L	2	" 106-A Br. Globe	Drain Filter
M	1	" 47-U Br. Gate	Shutoff Polisher Feed
N	1	" 47-U " "	Shutoff Cooler Feed
O	1	" 106-A Br. Globe	Drain Water Cooler
P	1	" 47-U Br. Gate	Shutoff Chilled Water Pump Feed
R	1	" 92-A Br. Sw. Chk.	Prevent Backflow Through Chilled Water Pump
S	1	" 106-A Br. Globe	Control Chilled Water Pump Feed To Carbonator

Code	Quan.	Jenkins Valves	Service
T	1	" 106-A Br. Globe	Drain Carbonator
U	1	" 47-U Br. Gate	Shutoff Water To Mixing Tank Meter
V	1	" 92-A Br. Sw. Chk.	Prevent Backflow Through Treated Water Meter
W	1	" 106-A Br. Globe	Control Water Feed To Mixing Tank
X	1	" 106-A Br. Globe	Control CO_2 Supply To Equipment
Y	1	" 106-A " "	Drain CO_2 Supply
Z	1	" 106-A " "	Control CO_2 Supply To Carbonator
AA	1	" 106-A " "	Control CO_2 Supply To Injector
BB	1	" 106-A " "	Control Carbonated Water Supply To Filler
CC	1	" *1313 S. S. Globe	Drain Liquid Sugar Tank
DD	1	" 1303 S. S. Gate	Shutoff Liquid Sugar Pump
EE	1	" 1329 S. S. Sw. Chk.	Prevent Backflow Through Liquid Sugar Pump
FF	1	" *1313 S. S. Globe	Control Liquid Sugar Pump
GG	1	" *1313 " "	Drain Liquid Sugar Line
HH	1	" 1303 S. S. Gate	Shutoff Liquid Sugar To Mixing Tank Meter
JJ	1	" 1329 S. S. Sw. Chk.	Prevent Backflow Through Liquid Sugar Meter
KK	1	" *1313 S. S. Globe	Control Liquid Sugar Feed To Mixing Tank

Code	Quan.	Jenkins Valves	Service
LL	1	" *1313 " "	Drain Flavor Tank
MM	1	" 1303 S. S. Gate	Shutoff Flavor Pump
NN	1	" 1329 S.S. Sw. Chk.	Prevent Backflow Through Flavor Pump
OO	1	" *1313 S. S. Globe	Control Flavor Pump
PP	1	" *1313 " "	Drain Flavor Line
RR	1	" *1313 " "	Drain Pressure Tank
SS	1	" *1313 " "	Control Flavor Feed To Mixing Tank
TT	2	" *1313 " "	Drain Mixing Tank
UU	1	" 1303 S. S. Gate	Shutoff Syrup Pump
VV	1	" 1329 S. S. Sw. Chk.	Prevent Backflow Through Syrup Pump
WW	1	" *1313 S. S. Globe	Control Syrup Pump
XX	1	" *1313 " "	Drain Syrup Line
YY	1	" *1313 " "	Control Syrup Supply To Syruper
ZZ	1	" *1313 " "	Vent From Pressure Tank
AAA	18	" 106-A Br. Globe	Control Pressure Gage
BBB	4	" 1312 S. S. Globe	" " "

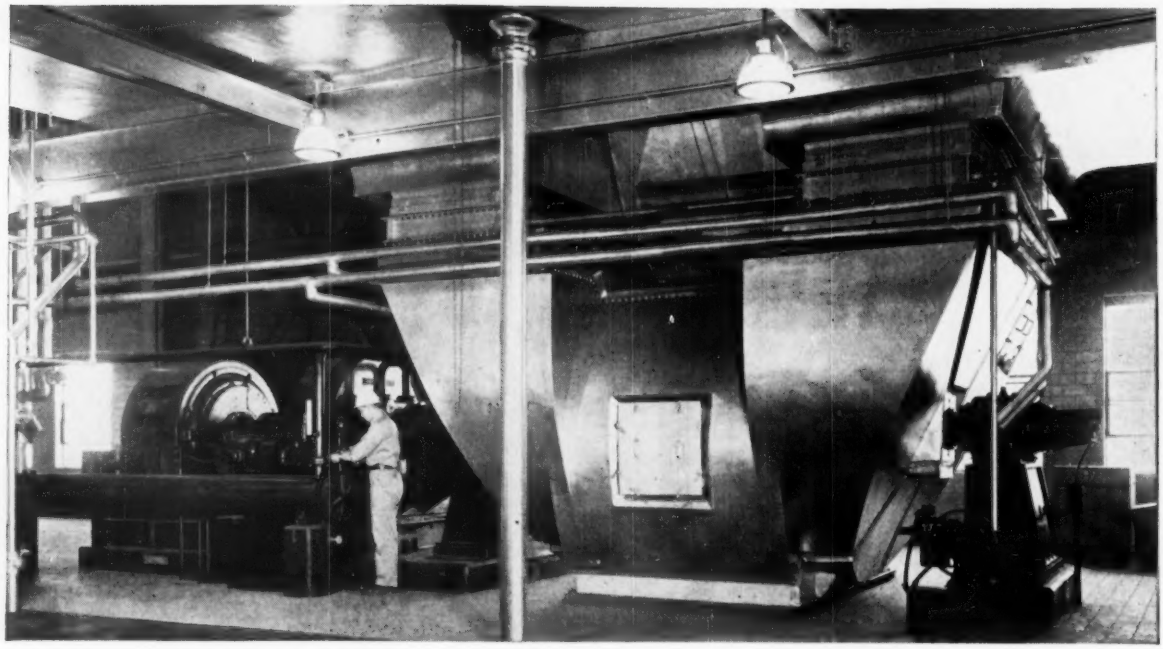
*Or Fig. 1317-A, Multiple Bolted Bonnet Globe

Sold Through Leading Distributors Everywhere

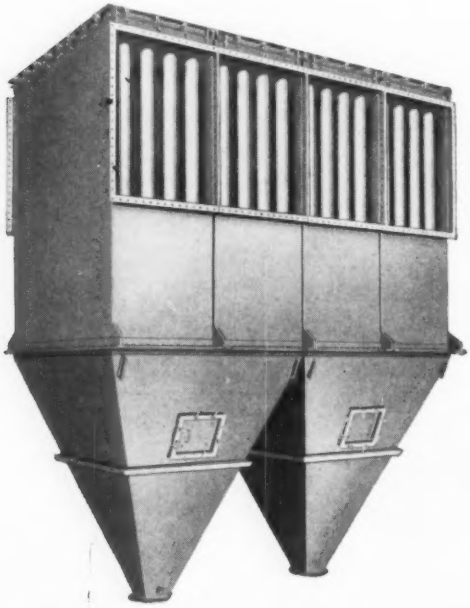
JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS
SINCE 1864
Jenkins Bros

American Blower Air-Handling Equipment

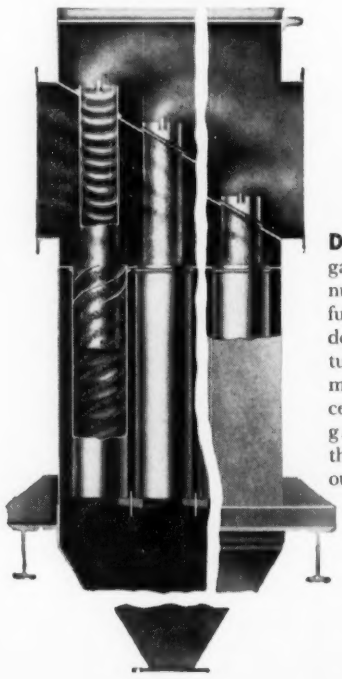
Proved efficiency



American Blower Induced-Draft Fans offer high static efficiency at low rpm. Like all American Blower mechanical-draft equipment, they are accurately formed and welded; fan rotors carefully balanced; all parts are minutely inspected for dimensional accuracy. They require a minimum space and minimum maintenance.



Series 342 Precipitator is easy to install and very effective in controlling fly ash. The over-all performance of each tube is comparable to the high efficiency of a small-diameter cyclone.



Dust-laden air or gas enters inlet plenum; gravity and centrifugal action force dust downward, adjacent to tube wall; dust is skimmed into gas-tight receptacle; cleaned air or gas moves upward through outlet tubes to outlet plenum.

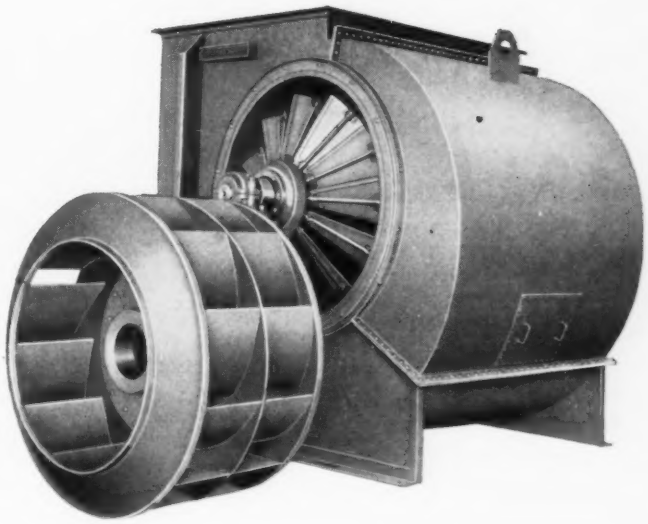
. . . maximum performance!

American Blower Mechanical Draft Fans

To meet the peak efficiency demanded of mechanical-draft equipment today, you'll be better off if you select spacesaving and efficient American Blower Mechanical Draft Fans.

Combining modern manufacturing methods with perpetual research and development, American Blower produces complete fan equipment for all types of mechanical draft. These induced-draft or forced-draft fans will fit your exact specifications with minimum maintenance and minimum boiler "outage."

If you are investigating mechanical-draft equipment—for new or existing installations—you'll do well to check on American Blower's line of Mechanical Draft Fans with guaranteed performance ratings. We welcome the opportunity of quoting on your requirements.



Forced Draft Fans for quiet indoor or outdoor installations. Heavy, reinforced housings and wheel-shaft assembly mean longer life, while special streamline inlets give utmost efficiency.

American Blower Precipitators

For maximum collection efficiency, choose the *best*—a dependable American Blower Precipitator!

Your fly ash problems can be met by installing a Series 342 Fly Ash Precipitator which offers good efficiency over the normal operating range, while it gives reliable, trouble-free performance.

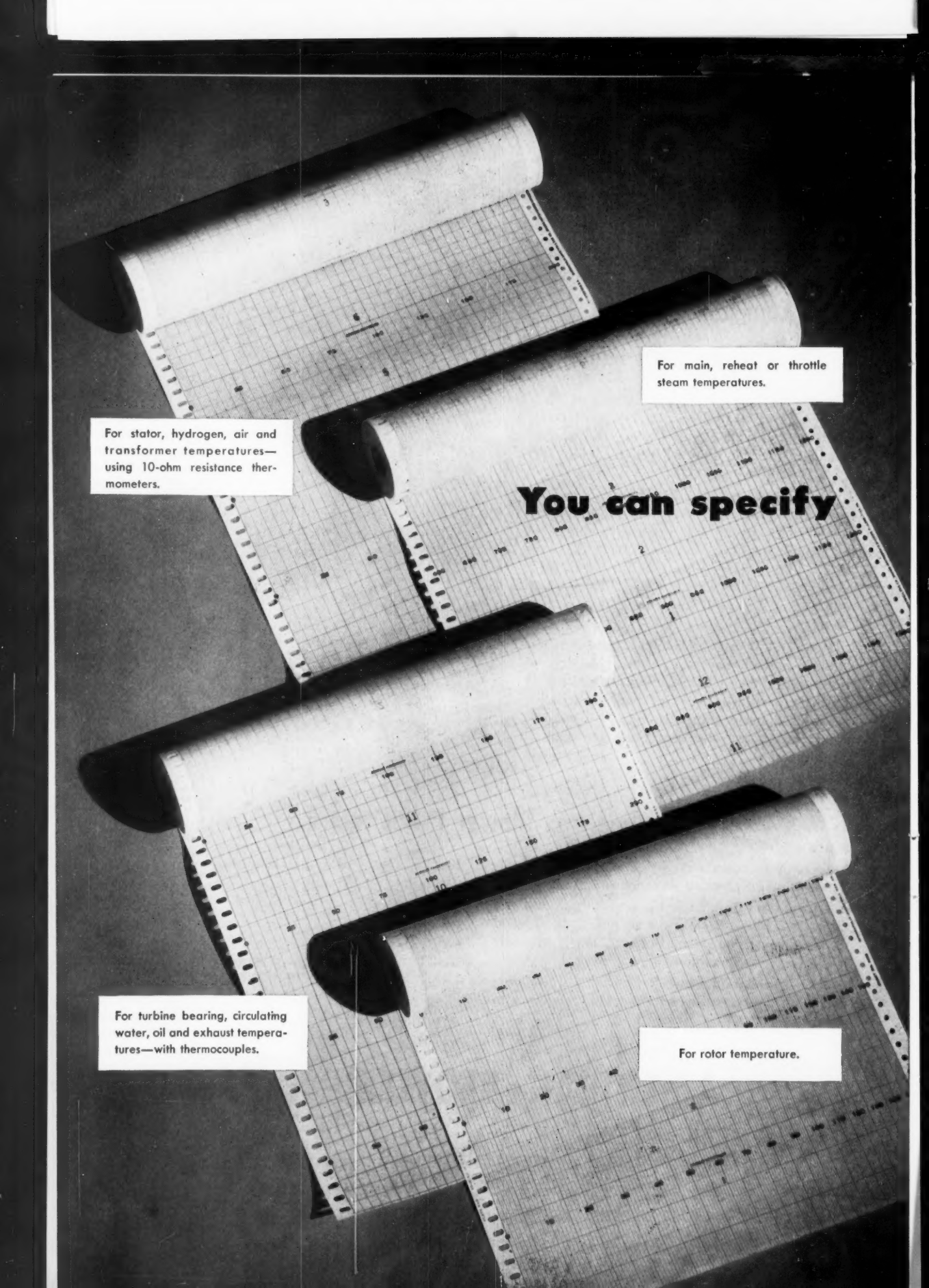
American Blower's line of Fly Ash Precipitators and Dust Collectors has gained wide acceptance in leading public utilities and industrial plants.

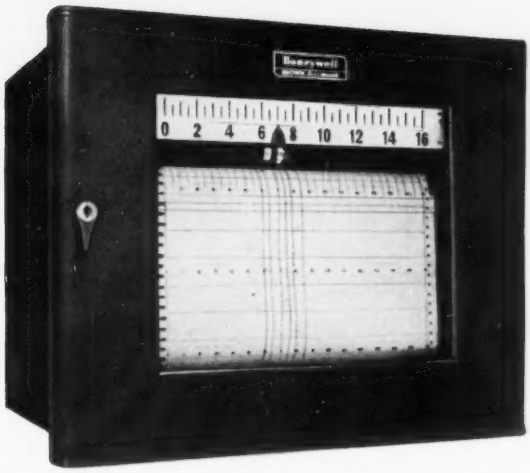
For complete information on American Blower Dust Collectors and Precipitators as well as other air handling products, call our nearest branch, or write direct. American Blower Division of American-Standard, Detroit 32, Michigan. In Canada: Canadian Sirocco products, Windsor, Ont.

AMERICAN BLOWER

Division of AMERICAN-Standard

QUALITY PROTECTS YOUR INVESTMENT... AMERICAN-Standard QUALITY IS AVAILABLE AT NO EXTRA COST


For main, reheat or throttle steam temperatures.
For stator, hydrogen, air and transformer temperatures—using 10-ohm resistance thermometers.
You can specify
For turbine bearing, circulating water, oil and exhaust temperatures—with thermocouples.
For rotor temperature.



ElectroniK strip chart recorders can be supplied for power plant use with scores of different temperature calibrations. Some of the typical standard charts are shown on the opposite page. Actual chart size is 11 inches in calibrated width.

an *ElectroniK* recorder

. . . for any of your temperature measurements

LET *ElectroniK* recorders keep constant watch over your plant temperatures—accurately, efficiently.

Choose one *ElectroniK* instrument to record a single temperature, or another to combine as many as twenty temperature records on a single chart. When several temperatures are combined on one chart, correlation is simple . . . operators can keep close check on trends . . . engineers can analyze operation in accurate detail.

Built-in circuits adapt these recorders for signalling excess temperatures. And there's a complete Honeywell line of thermocouples, extension wires, and power-plant-type resistance thermometers to work with *ElectroniK* instruments.

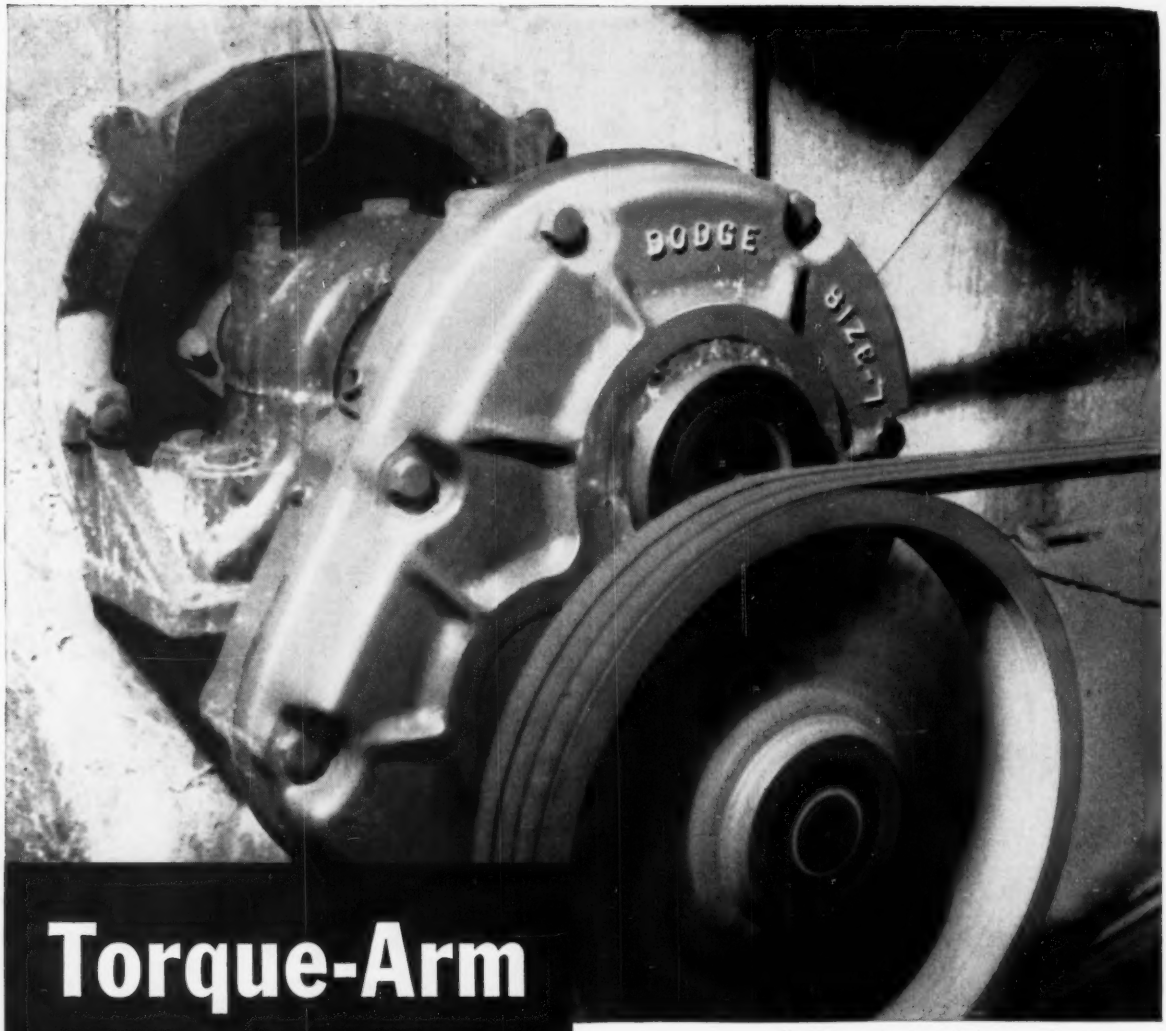
ElectroniK instruments are famous for their stamina and dependability. For a discussion of how they can be applied to measuring your plant temperatures, call your local Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Bulletin 9070, "Instruments for Electrical Power Generation."

Honeywell

First in Controls

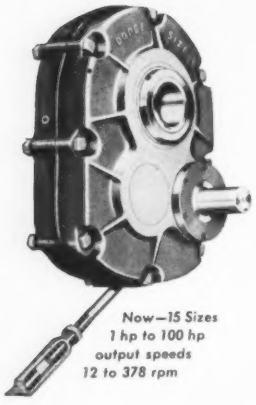


Torque-Arm

SHAFT-MOUNTED SPEED REDUCERS

Size 7 Torque-Arm Speed Reducer on a Shartle Agitator

Save Up to 1/3 in Installation —Deliver 97% Efficiency!



Now—15 Sizes
1 hp to 100 hp
output speeds
12 to 378 rpm

Easy to install! Mounted directly on the driven shaft. Locked at both ends. Dodge Torque-Arm Speed Reducer requires no foundation, no flexible coupling, no sliding base, and there's no lining-up problem. Amazing economy is matched by efficiency in operation—up to 97%.

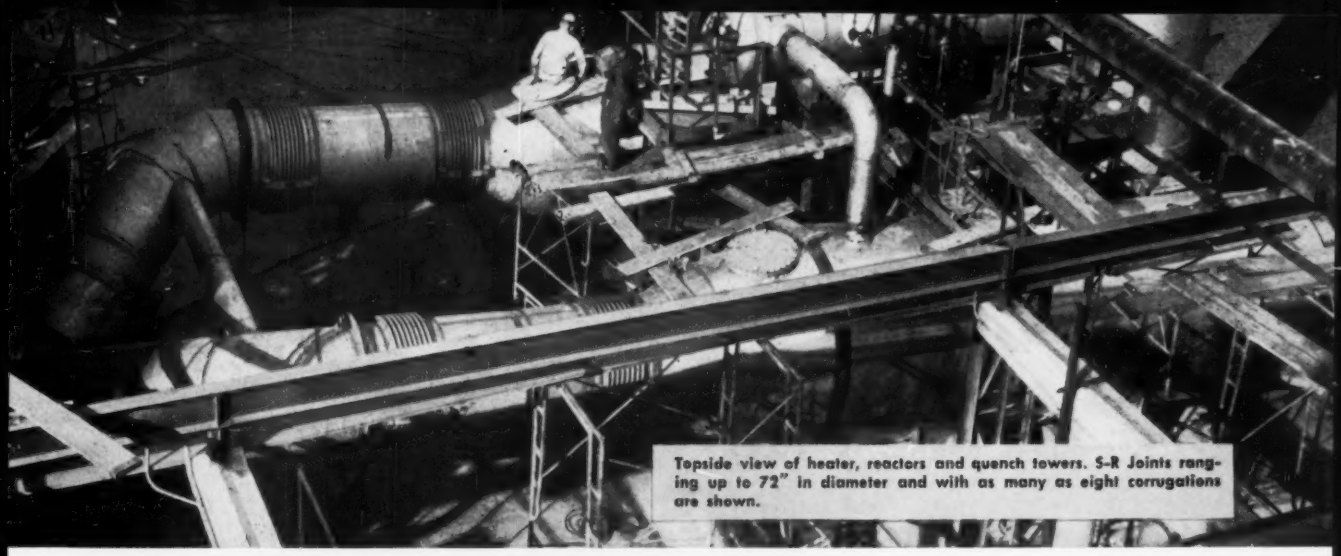
Unit is driven through V-belt drive. Stock Taper-Lock Sheaves prescribed for each job permit speed ratios required. Tri-Matic Overload Release and backstop available, if desired. Dodge Torque-Arm is America's most complete line of shaft-mounted Speed Reducers. Ask your Dodge Distributor—or write us.

•

DODGE MANUFACTURING CORPORATION
3200 Union Street, Mishawaka, Indiana

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new methods. Look for his name under "Power Transmission Machinery" in the yellow pages of your phone book—or write us.

DODGE
of Mishawaka, Ind.



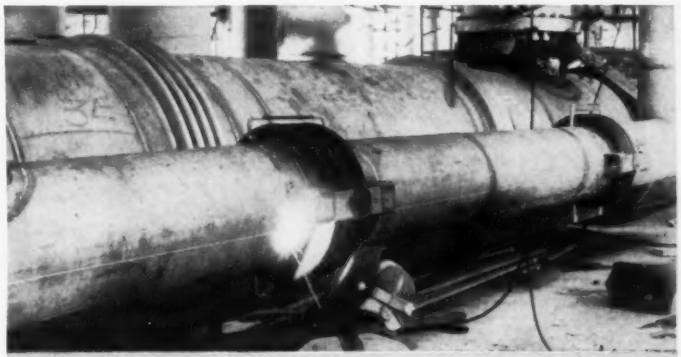
Topside view of heater, reactors and quench towers. S-R Joints ranging up to 72" in diameter and with as many as eight corrugations are shown.

188 Badger Expansion Joints Protect Equipment in Texas Butadiene's New Plant

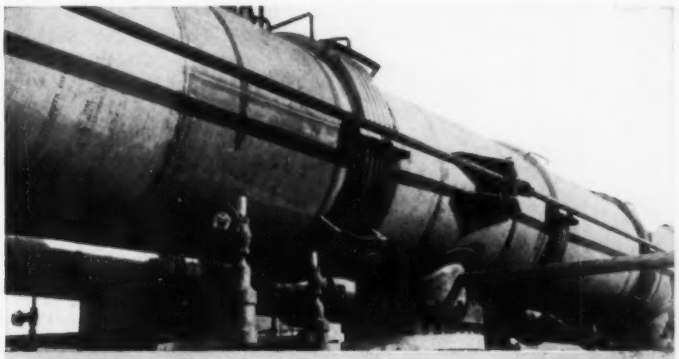
At the time Texas Butadiene's new plant was designed, engineers figured that the high temperatures required by the process would cause excessive pipe expansion — and possible damage to equipment. They solved this critical operating problem by specifying Badger S-R Expansion Joints — *to absorb and control pipe movement.*

Now — with a total of 188 Badger Expansion Joints in operation (ranging in size from 14" to 72") — Texas Butadiene's new plant at Lyondell, Texas is making processing history. Designed to solve just such exacting expansion problems, the Curvilinear Corrugations and tubular Reinforcing Rings of S-R Expansion Joints insure better equalization and longer cyclic life (see diagrams below).

Size for size, new Badger S-R Joints weigh up to 50% less than conventional types . . . and their new ring design reduces joint diameter. A complete line of accessories — including covers and liners — is available. *Write today for fully illustrated brochure.*



Large line (air in — air out — product out) under reactors includes twelve S-R 48" stainless steel joints to handle temperatures of 1150° F. at 35 psig. Small evacuation line uses fourteen 16-inch S-R Joints.



Close up of Regeneration Air Line. This line has fourteen 48" stainless steel S-R Joints handling temperatures over 1000° F.

New corrugation and ring designs produce better equalization, "all-curve" flexing

Curvilinear Corrugations used in S-R Expansion Joints were developed by the Badger Research Department. Under operating pressures (white line) the new design produces more uniform movement per corrugation and natural "all-curve" flexing. Stress is reduced . . . life increased.

Series 50 corrugation cross-section

S-R Joints for higher pressures have tubular Reinforcing Rings. These new rings make metal-to-metal contact only in the "valley" of each corrugation allowing natural "all-curve" flexing (white line). Tubular shape permits greater effective flexing height which contributes to longer joint life.

Series 150 corrugation and ring cross-section

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SERVICE RATED

EXPANSION JOINTS

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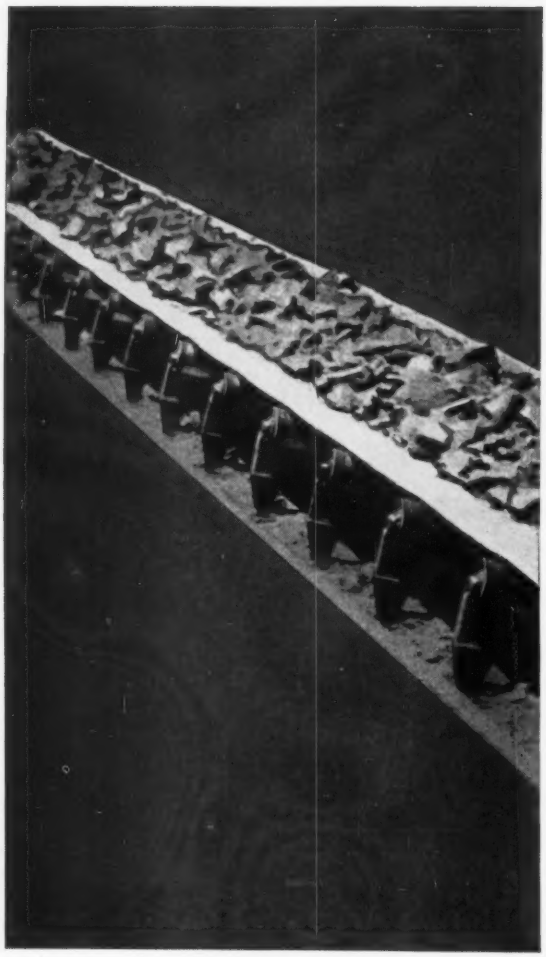

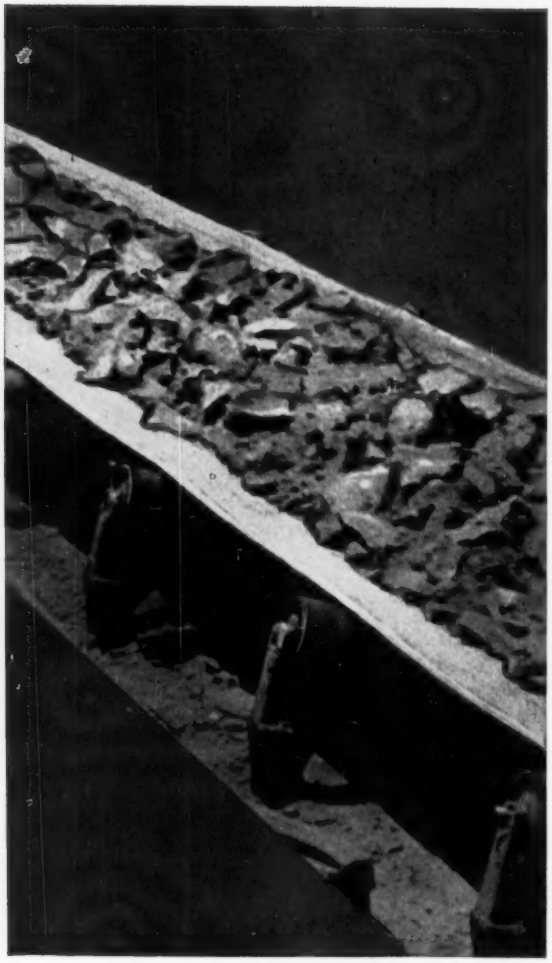

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"More Use ~~per~~ Dollar"

It's the *last* one-third of conveyor belt life that determines its final cost. Real conveyor belt cost is the cost per foot of belt in terms of load carrying capacity for the *potential service life of the belt.* R/M's new conveyor belt construction now assures you ⅓ longer belt life! Here's why:

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Let an R/M representative show you how *extra* life in the last ⅓ of conveyor belt service means "More Use per Dollar" with Ray-Man Conveyor Belt and other R/M heavy duty constructions.

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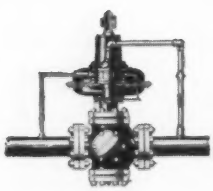
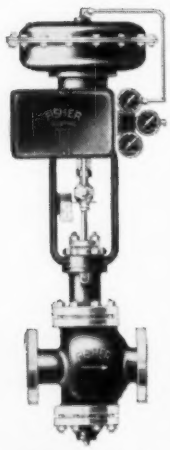


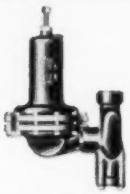
IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD... CHANCES ARE IT'S CONTROLLED BY...



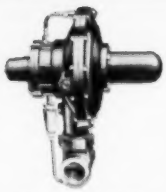
Type 657 with 3500 Positioner

Type 4150 and 4160 Wizard II Pressure Controllers

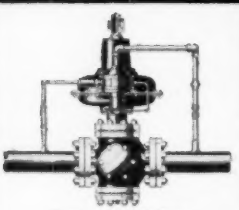
Type 95 Pressure Reducing Valve



Type 630 "Big Joe" Field Regulator



Series 99 Multi-Purpose Gas Regulator



Series 298T Gas Regulators

Type 655-A Pressure Regulator

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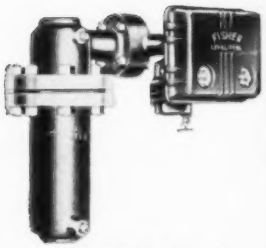

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259B Level-Trols
Cage Sizes 14" and 32"

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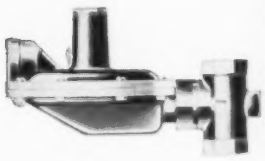
Reducing Valve



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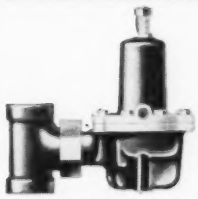
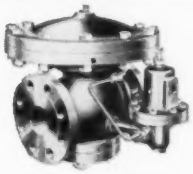
Service Regulators



Series 620 and 621
Farm Tap Regulators



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Now, when you're up against an emergency, phone, wire or TWX (Marshalltown 578 or 579) the factory or your Fisher representative ... your order will be enroute within 36 hours (except Saturday and Sunday) after it is received in Marshalltown.

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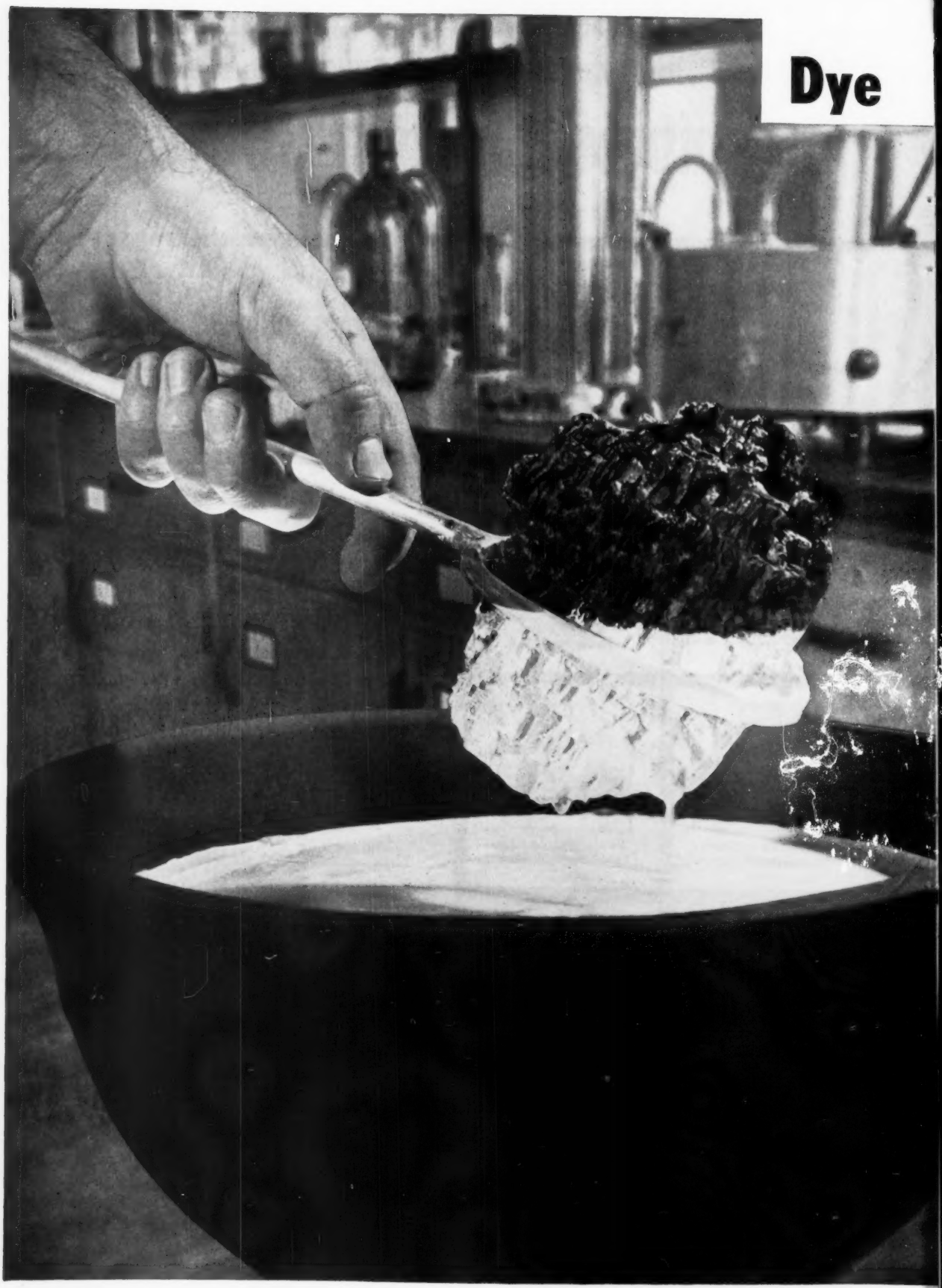

maker brightens fuel cost picture

Burning coal at Toms River-Cincinnati saves 20% on fuel costs, permits clean steam generation

The Toms River-Cincinnati Chemical Corp. plant in Toms River, N.J. is the most modern plant of its kind in the world. Producing vat dyestuffs requires a large dependable steam supply for chemical processes and heating purposes. To fill these requirements, the power plant at Toms River-Cincinnati is as up-to-date and efficient as the general plant itself. The fuel used for steam generation is *coal* because, on the basis of cost per thousand pounds of steam, the nearest competitive fuel costs 20% more than coal. In addition, thanks to automatic operation and modern equipment, the power plant meets the rigid standards of cleanliness required in such manufacturing operations.

Facts you should know about coal

Not only is bituminous coal the lowest-cost fuel in most industrial areas, as in the case of Toms River-Cincinnati, but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment pares labor costs and eliminates smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

The Bituminous Coal Institute offers a free technical advisory service on industrial fuel problems. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—will effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

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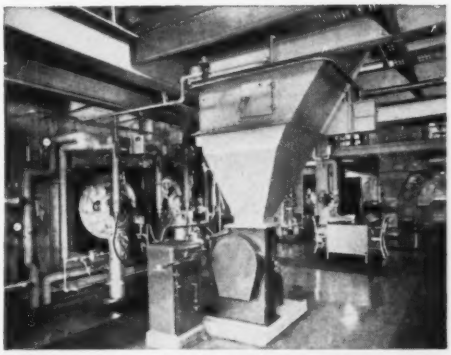
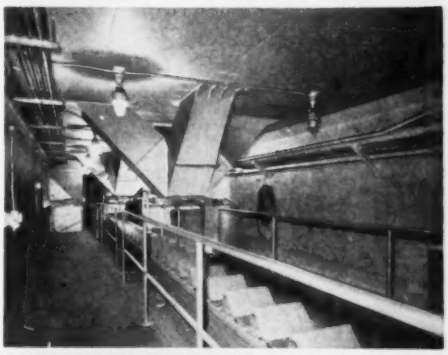
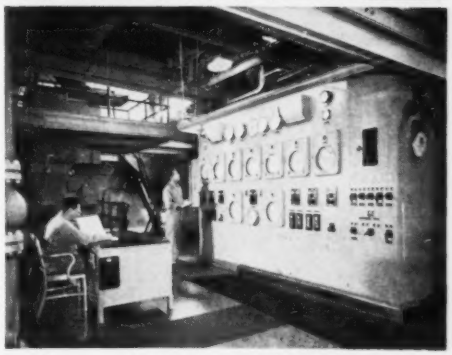


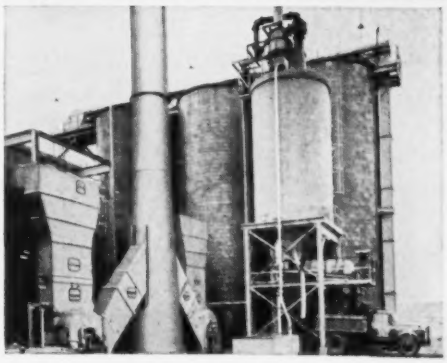
View of boiler room showing both 50,000 lbs. hr. boilers, by Riley Stoker Corp. Each has two burners. Center foreground is automatic weigh scale, by Richardson Scale Co., which receives coal through hopper from live storage bin and passes it to coal feeder. Coal is fed to Riley Pulverizer in basement, then blown back up to burners.



Close-up of Gifford-Wood Roundabout Bucket Conveyor beneath coal storage silos. Transversing feeder-car is used when coal is emptied from silo and conveyed to live storage bin.



Automatic combustion control and instrument panel by Bailey Meter Co.



Fly ash being loaded on truck through a dustless rotary unloader. Fly ash is collected by Prat-Daniel Mechanical Precipitators. A pneumatic ash collecting system by United Conveyor (with tie-ins under air heater and at base of stack) removes it to this 20-ton ash silo. In the rear are three 330-ton coal silos.

WHEN YOU USE "BUFFALO" CLOSE-COUPLED PUMPS

"Buffalo" CCL Close-Coupled Pumps can't be beat where space is limited. They are easy to install with permanently aligned shafts and adjustable discharge angle. This provides extreme adaptability in piping and mounting.

Thanks to 81 years of engineering experience, "Buffalo" Close-Coupled Pumps insure you a long, trouble-free life of dependable service. Their rugged construction includes heavy cast mounting brackets, sturdy shells, accurately machined impellers, and deep stuffing boxes.

Where you need space-saving pumps, designed to deliver *extra* years of clear water service, be sure to use "Buffalo" CCL Close-Coupled Pumps, capacities to 1100 GPM. Bulletin 975-D gives you full information. Write for it today.

You're assured of value in "Buffalo" products by the "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.

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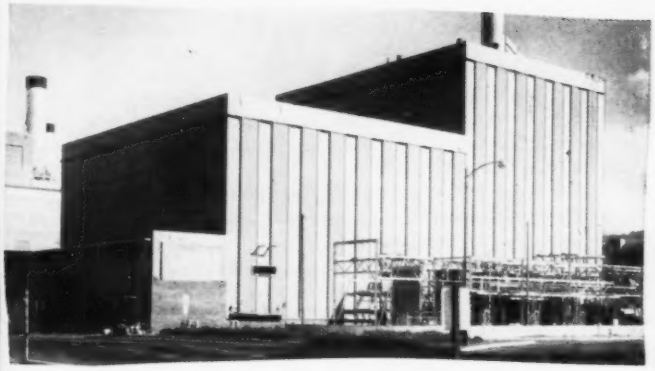
INSULATION GUIDE

Temperature	Recommended Pabco Insulation
to 350° F.	85% Magnesia pipe covering, block, cement
to 1200° F.	Caltemp pipe covering, block, cement
to 1600° F.	Presco 15 C pipe covering, block, cement
to 1900° F.	Presco 19 C block



Curb expensive heat loss, control temperatures within minimum tolerances with performance-proved Pabco Insulations.
For power plant piping and equipment, a Pabco Insulation insures peak performance wherever temperatures must be maintained up to 1900° F. Pabco's Caltemp and 85% Magnesia insulations are "Precision-Molded" by a patented process in both pipe and block form. For data on technical advantages . . . case histories . . . or engineering consultation, write . . . or call . . . a Pabco insulation engineer.

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THE dimensional accuracy of B&W Welding Fittings makes a welder's job easier and helps to make his work more precise. Trouble caused by poor fit-up to pipe is eliminated. Every fitting has true circularity, full radius and walls of uniform thickness, which result in time saved in installation, top-quality joints, and helps to achieve a permanent, leak-proof, piping system. Write for bulletin FB504.

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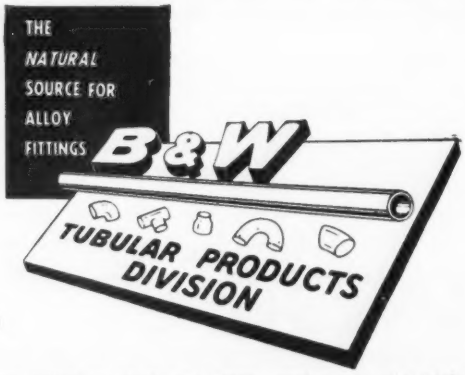

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LOUIS N ROWLEY, EDITOR • FEBRUARY 1958 • ESTABLISHED 1882 **Power**

Think ahead . . . or pay the price

THE experts say that man, as we know him, has been living on this planet for 50,000 years. For more than 49,900 of those years, he was earthbound. Now, only 55 years after the Wright brothers made their first short and precarious hop at Kitty Hawk, the Sputniks signal the invasion of outer space. Thus has the pace of technical progress accelerated.

Another measure of this avalanching of technical advances was given by J Lewis Powell* in a recent speech. To make that 50,000-year span more manageable and to give perspective to what happened during it, he asked his audience to condense the 50,000 years to 50—a typical adult memory span.

On this basis, men stopped living in caves only ten years ago. Someone invented picture writing five years ago. Christianity started two years ago. The printing press was invented five months ago. Electricity became a practical reality 10 days ago. And jet planes came into being since you started to read this page.

Any way you look at it, technology is moving forward at an ever-faster pace, with tremendously important implications for all of us. Never has it been more important to be fully and accurately informed and never has it been more important to think ahead.

Weaknesses in both these areas lie at the root of our present dangerous position in the missiles race. We have underrated the Russians because we didn't know enough about them and we continued to think of them in terms of the past. Had we been paying attention to Soviet technical literature we would have known about Sputnik months before it startled the world.

Nor have we known enough about our own activities. It seems clear that there hasn't been enough interchange between the various agencies working on missile projects. Equally important, information available to the public hasn't been adequate to develop the pressure of opinion that might have forced stronger, better directed action. Finally, it seems fair to say that at least some of our official thinking has been geared to the past and not to the future.

All this is important to each of us as citizens. But it has a particular significance to us as engineers in our private concerns. In the more leisurely times of our fathers, failure to be well-informed and to think ahead carried only modest penalties. At today's accelerated pace, being five years out of date in our thinking is equivalent to a 50-year lag in our father's day, and can be fatal. Today's engineer cannot discharge his responsibility to himself or to his company unless he consciously strives to keep abreast of the new developments in his field and, even more importantly, unless he learns to think in the future world of technology—a world that takes shape faster and more meaningfully than it ever did before.

*Office of the Assistant Secretary of Defense (Supply and Logistics)

Announcing

another outstanding development soon to be available by the makers of BUSS FUSES

FUSETRON

LOW-PEAK

FUSES

Have

CURRENT LIMITING

added to

High Interrupting Capacity

and

Long Time-Lag

Made in all standard sizes above 60 amperes

FUSETRON Low-Peak Fuses are made in all standard sizes above 60 amperes—both 250 and 600 volt ranges.

In 60 amperes and smaller sizes tests show that FUSETRON dual-element fuses have sufficient current limitation to protect circuit and components in all normal cases.

Now you can have a high degree of protection against the thermal and mechanical stresses that heavy fault currents often impose on switches or other circuit components.

FUSETRON Low-Peak Fuses have a current limiting element that cuts off fault current so fast that it cannot build up to a damaging peak.

These new FUSETRON Low-Peak Fuses are built on the same principle as FUSETRON dual-element Fuses. They have:

the same High Interrupting Capacity

the same Time-Lag to hold harmless current surges

PLUS Greater Current Limitation to restrict fault currents to a LOW PEAK

FUSETRON Low-Peak Fuses can be interchanged with FUSETRON dual-element Fuses.

Where their use is required in any part of the electrical system, they can be installed without upsetting proper coordination over the range of useful loads and normal faults.

Hence, their application requires no testing or complicated calculations.

They are designed for use to protect circuits and components that might be damaged by the thermal and mechanical stresses of peak fault currents if other protective devices are used.

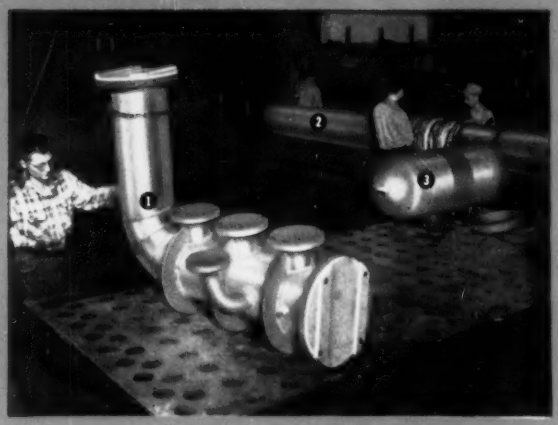
If planning new installations, keep FUSETRON Low-Peak Fuses in mind for those locations where peak fault current must be held to a low value.

BUSSMANN MFG. DIVISION

UNIVERSITY AT JEFFERSON, ST. LOUIS 7, MO.

McGRAW EDISON

ALL IN A DAY'S WORK at *Pittsburgh Piping*



These three jobs are typical of the wide variety of custom piping work which we do for the power and process industries. In the background of the photo welders are shown making the heli-arc root pass on 18" O.D., 3.875" wall, chrome-moly main steam piping. In the foreground, ready for final inspection, is a 12" header for a process operation, fabricated of ⅜" aluminum alloy. The pressure vessel, of austenitic steel, is one of many we produce for atomic energy application. The manufacturing of this type of piping requires specialized facilities . . . for engineering, fabricating, testing, assembly, and erection. We have those facilities. Use them on your piping jobs.

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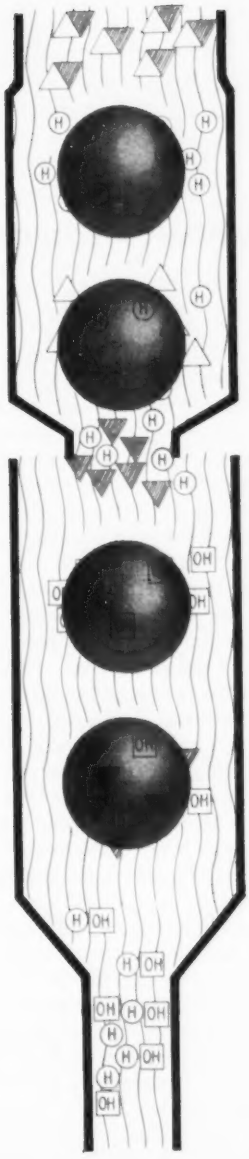
B G A SKROTZKI
Associate Editor in Charge

a Today's Development report

Industrial demand for high-quality water at lowest cost spurs use of more complex . . .

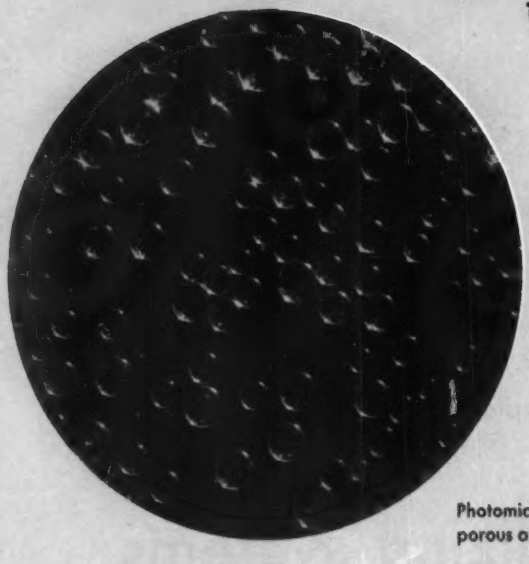
Demineralizing systems



By ROBERT H MARKS
Assistant Editor

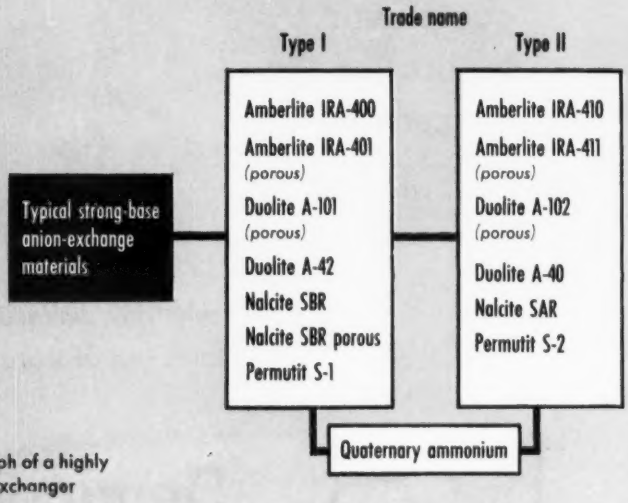
- Expanding variety of ion-exchange material makes it possible to tailor each treatment system more closely to raw-water analysis and needed water quality
- New techniques include train operation and countercurrent series regeneration. Upflow acid regeneration shows much promise. Look for more polishing units
- Use of automatic controls continues its upswing. Giant multibed system at Linden Station of Public Service Electric and Gas Co is prime example. See pages 74-75
- Nuclear and supercritical power plants will rely more and more on mixed-bed systems for makeup needs and condensate or coolant purification

Industrial-water use is climbing to new highs, straining our sources of supply. Getting more from available water is and will continue to be the watchword of industry. The effect of water quality on plant operation and production is in for closer scrutiny than ever before. Demand for high-grade water will also be heightened by further refinements in the yardsticks of water quality. The best water obtainable is already a must for nuclear and very-high-pressure power plants as well as for a growing number of industrial processes. Use of demineralizing systems to treat makeup water is widespread for high-pressure boilers above 1250 psi. But in the



Photomicrograph of a highly porous anion exchanger

These materials can reduce soluble silica to 0.02 ppm



Expanding variety of ion-exchange materials are the

medium-pressure range from 600 to 1250 psi they haven't made much headway. The old reliable hot-process is still the most popular. Greater use of demineralizing in this area awaits lower equipment and operating costs. In many cases, however, intangible advantages of top-quality water and an automatic treatment system may tip the scales in its favor. With the development of proven automatic chemical analyzers, completely automated demineralizer control will be more of a factor.

Water quality is also critically important in many of the process industries. Such diverse products as tin plate, television tubes, synthetic fibers and *thermopane* make good use of demineralized water. Applications like these will increase as competition forces other industries to explore every way of lowering costs and improving quality. With a booming demand for high-quality water there will be a continued expansion of the market for today's complex demineralizing systems.

Ion-exchange materials

Chart, above, groups the most commonly used ion exchangers under three main headings: (1) strong-base anion (2) weak-base anion (3) cation. It's difficult to generalize on their specific properties because exchange capacity and efficiency vary with water analysis, regeneration technique and amount of leakage. But, with these exchangers, each of today's demineralizing systems is tailored to raw-water analysis and desired quality.

Strong-base exchangers' biggest problem is biological fouling with resulting loss of capacity on some waters. But newer porous resins are expected tc give better performance. Theory is that they hold organic ions more loosely, making it easier to remove them with chemical treatment. Others feel increased porosity is not the solution to this problem. Field operating experience on many different waters will render the final verdict. In general, Type I resins are more stable and are preferred for silica removal even though capacity and efficiency is lower than Type II.

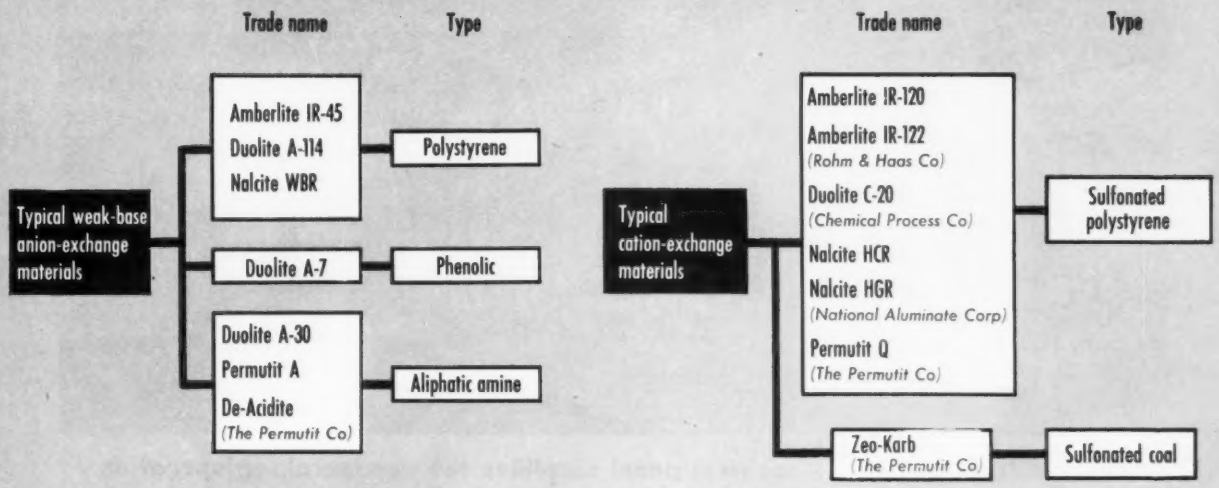
Weak-base exchangers were almost completely replaced by strong-base types in feedwater treatment. But their capacity and efficiency is still much higher for chloride and sulfate removal. And their cost is less than half that of the strong-base units. So now both types are used in multiple-bed systems, taking advantage of the best properties of each. Styrene-base types, like *IR-45*, are the most recent development. Capacity is higher than the older phenolic and aliphatic-amine types, and resistance to chlorine attack is much improved. Look for increased use in multiple-bed demineralizing systems.

Cation exchangers have a long and successful operating record. Carbonaceous type will still find jobs where cost and acid efficiency give it a decided advantage over other exchangers. But styrene-base resins will continue to be the workhorse for cation exchange. Newer types, such as *Nalcite HGR*, have a higher degree of cross linkage to resist oxidation deterioration better.

System hookups

Waters with low total dissolved solids, easy and economical to treat with a simple two-step or mixed-

Weak-base exchangers are most efficient at removing chlorides, sulfates, nitrates



heart of today's sophisticated demineralizing systems

bed demineralizer, are fast becoming rare. A multiple-bed hookup is usually needed to (1) produce desired quality (2) reduce chemical operating cost (3) keep equipment cost down.

Polishing units are now very popular. Basically, they scavenge any leakage or slippage from the primary plant and insure high-quality water. Their work load isn't heavy so they can operate at high flow rates (about 15 gpm per sq ft). Need for regeneration is infrequent and can be done separately or in series with the primary exchangers.

Alternating series is another variation of the polishing theme. Secondary units are the same size as primary units and are used alternately in both positions. It's a flexible plant that can operate at twice its normal rating in parallel. But, since all units are regenerated on regular daily schedule, the benefit of polishing is lost during these regeneration outages. Cost is usually more than a high-rate polishing system.

Use of weak-base exchangers and vacuum degasifiers is on the increase. Both help lower chemical operating cost by reducing load on the strong-base exchanger. In some cases overall equipment cost is less. Weak-base units are called for on waters with a high proportion of chlorides and sulfates. Vacuum degasifiers pay off on waters that are high in bicarbonate alkalinity. And they have the added advantage of removing oxygen.

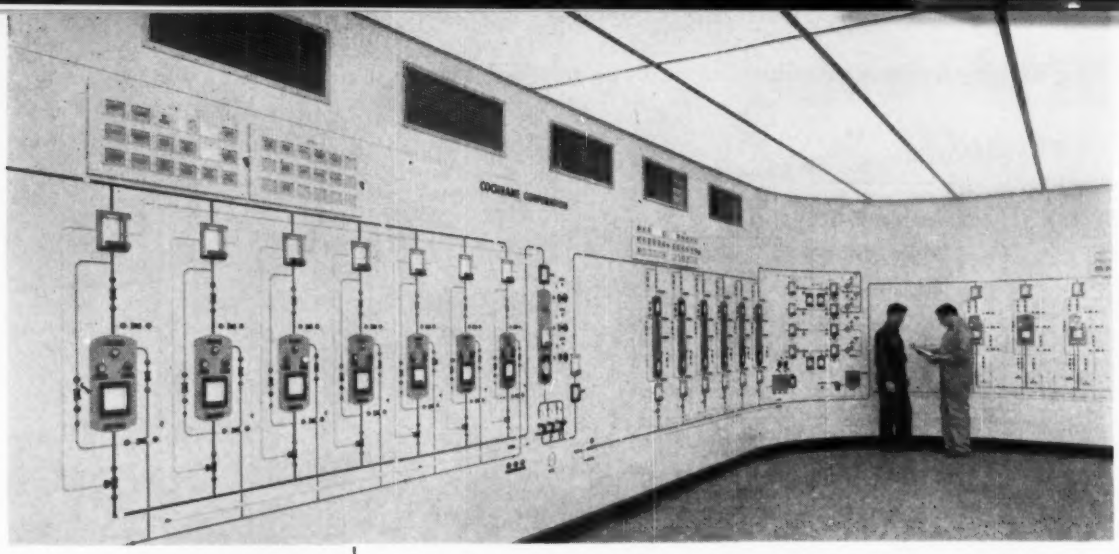
Since multibed systems of this type are most efficient on high-solids water, effluent quality is usually a problem. Weak-base anion followed by a strong-base anion won't give as good silica removal as two strong-base units in series.

Countercurrent series regeneration is one way to get around this. It permits use of weak-base exchangers for low operating cost and keeps water quality on a par with other polishing hookups. Total caustic for both units is first passed through the strong base and then through the weak base (this is countercurrent to flow of water through the plant). The strong base in effect gets a super-regeneration at almost 100% efficiency.

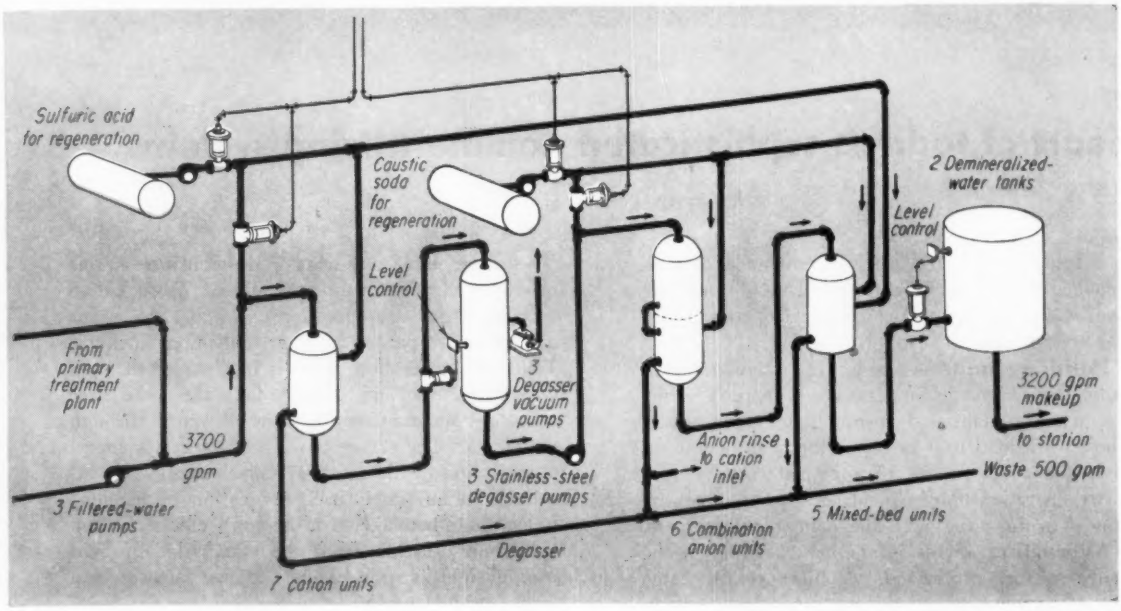
Same technique is used for cation exchangers. It has the advantage of using most efficient rating on primary cation from the standpoint of acid consumed. Increased cation slippage is picked up on the secondary unit.

Train operation comes into the picture because it's the simplest way to operate a complex multibed system having countercurrent regeneration. Operating run of a single line or train of ion exchangers is designed to coincide. The complete train is then taken off the line for regeneration. By combining steps it's possible to regenerate all the units in a train in three to four hours.

Upflow or Counterflow Regeneration has much future promise. P H Casky and T P Harding reported their experience with Counterflow Regeneration at Omaha Public Power District (1957 American Power Conference). In a comparison with downflow regeneration, acid consumption was reduced from 11.0 to 7.4 lb per cu ft. And sodium leakage was greatly reduced. Successful operation depends on preventing cation-bed expansion with resulting acid flow channeling. This is done by keeping a downward flow of water in free space over the cation bed while acid enters upflow.



Large, central, graphic control panel simplifies the demineralizer operation



Two operators run this giant 5-step demineralizing plant

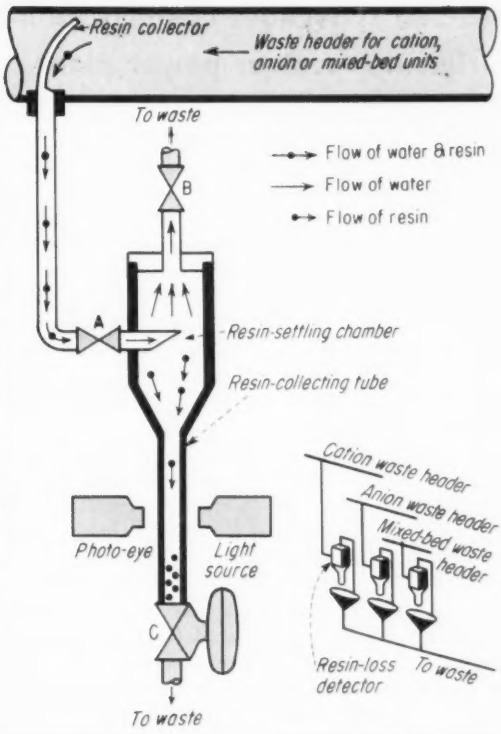
It's an outstanding example of the growing trend to fully automatic regeneration and control of demineralizing systems

Linden Generating Station of Public Service Electric and Gas Co furnishes all the steam for the Bayway Refinery of Esso Standard Oil Co in exchange for fuel and raw water. The water is purified, filtered and demineralized for makeup to the station's high-pressure boilers (2000 and 2350 psig).

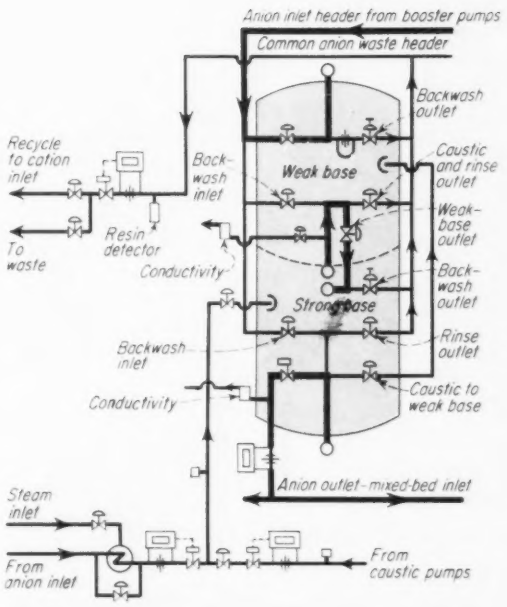
Pretreatment system delivers water that is essentially free of turbidity, color, oil and organic matter for the demineralizer. Total dissolved solids run about 300 ppm. The demineralizer in turn reduces total dissolved solids to 0.2 ppm, dissolved silica to 0.01 ppm, total silica to 0.02 ppm and conductivity to 0.5 micromhos.

Flow diagram, above, shows the 5-step system used at this plant. All of the ion-exchange units, which are among the largest ever built, are 12 ft diameter. Although single units are shown, the plant actually includes seven cation, six combina-

Many unique features set the pace for future demineralizer installations



RESIN LOSS DETECTOR automatically signals presence of any excess resin in each of exchanger's waste headers



COMBINATION-ANION UNIT contains both weak-base and strong-base material in a novel design that saves floor space

tion-anion and five mixed-bed exchangers. Capacity is now 3200 gpm and can be expanded to 4800 gpm by adding more units. Regeneration is completely automatic, with only two operators per shift running the entire treatment system.

Need for continuous production of demineralized water calls for an unusually complete and automatic control system. Full plant capacity is obtained with one unit of each type regenerating and another off the line for routine maintenance. All known ways were explored to reduce operating cost and improve effluent quality.

Operating cost picture is improved by (1) anion rinse recycling (2) backwash water recovery and recovery of certain rinse waters (3) caustic reclaiming from mixed beds (4) hydraulic loading and unloading of ion-exchange resins and (5) provision for chemical cleaning of resins in place or in a separate treatment tank. This controls long range effects of anion-resin fouling.

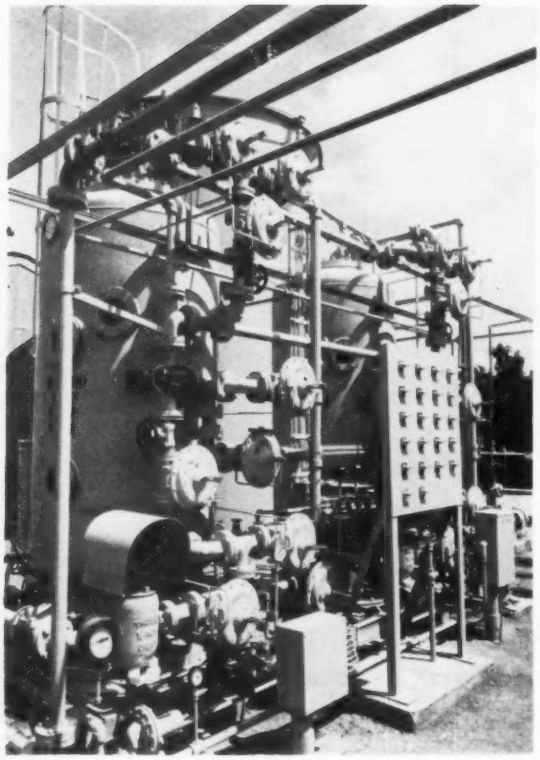
Cation exchangers are operated at their most efficient acid regeneration level. So there is considerable sodium leakage by usual operating standards. This gives necessary cation load for polishing mixed beds. But to keep leakage at a minimum and fairly constant during the run it's necessary to use an upflow hydraulic mix after the acid injection step during each cation unit's regenerating cycle.

Conductivity control monitors the cation run. Each unit conductivity is measured and compared with the average conductivity from the whole battery. Preset difference indicates exhaustion.

Resin loss detector, above, helps conserve expensive exchange resins. Collector diverts water and resin in waste header through valve *B*. Any resin settles in the collecting tube. When resin level builds up to the photoelectric cell, an alarm sounds and backwashing is stopped. Valve *C* opens at the end of each regeneration cycle and the accumulated fines are sent to waste.

Combination-anion unit, above, eliminates both weak-base outlet and strong-base inlet headers. It also saves floor space. Strong-base and weak-base sections are regenerated as a unit. High weak-base conductivity or a preset conductivity difference between each strong-base and average effluent from the battery will end the operating run.

To regenerate, backwash both beds at the same time. Then introduce caustic concurrently from strong base to weak base. Use caustic displacement rinse to send caustic to the weak-base bed. Follow this by another backwash and a fast rinse to waste. Then start rinse recycle when the rinse water dissolved solids drop to raw-water level.

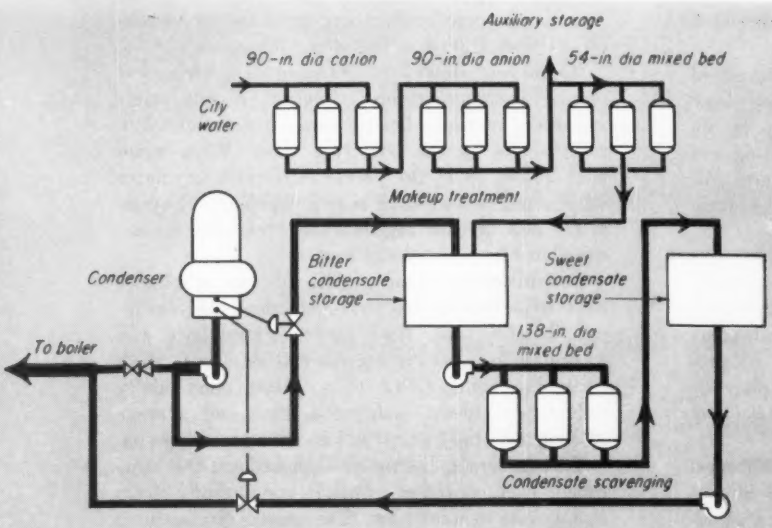


Mixed-bed scavenges condensate in experimental nuclear power plant

Mixed-bed demineralizers, left, are located at the Sodium Graphite Reactor Experimental Station of Southern California Edison Co. They operate in condensate circuit to remove any soluble material picked up in feedwater steam cycle. The reactor is giving valuable operating data on use of liquid sodium in heat exchangers. Radioactive sodium from reactor heats an intermediate sodium stream. This, in turn, supplies heat for the liquid metal to water steam generator. Feedwater dissolved solids must be kept very low because generator is essentially a once-through type. Chlorides and oxygen are also kept at low levels to avoid trouble with stress corrosion cracking of the stainless-steel generator.

Demineralizing system is multiple-bed type. It supplies makeup needs in addition to condensate scavenging. High bicarbonate alkalinity makes it economical to pretreat raw water ahead of the mixed bed. This is done with a hydrogen exchanger followed by a vacuum degasifier to remove resulting carbon dioxide as well as oxygen. Enough raw water is by-passed around cation unit to furnish sufficient cation load for the mixed-bed unit. System is designed for automatic regeneration with special conductivity controls used to detect end of the operating run on each exchanger in the battery. Mixed-bed equipment treats both makeup and condensate.

Nuclear and supercritical power plants will depend on mixed-

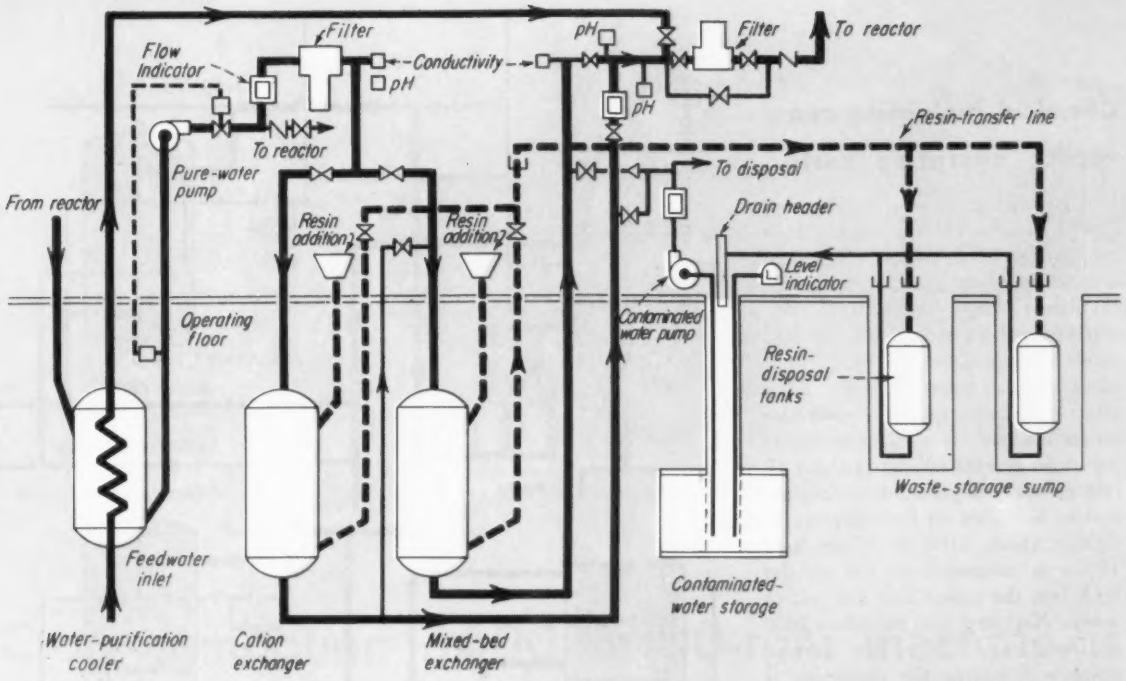


MIXED-BED DEMINERALIZERS play an important role in makeup treatment and condensate scavenging at Eddystone Station of Philadelphia Electric

Demineralizers have found an important niche in polishing and scavenging service. Case-in-point is the Eddystone Station of Philadelphia Electric. Feedwater solids for their 5000-psig 1200-F supercritical boiler must be reduced to the vanishing point. Any solids present will carry over with the steam and slowly build up in the system.

Water treatment problem is tackled from two general directions. First dissolved solids are removed from the makeup. Then provision is made to keep condensate at the same high quality. Principal sources of contamination are condenser leakage and pickup of small amounts of metal from the steam-condensate cycle.

Makeup is prepared by the multiple-bed demineralizer system, at left. It operates on raw city water containing about 100 ppm dissolved solids. Primary 2-step section reduces these to 0.5 to 3.0 ppm level and dissolved



CATION EXCHANGER and mixed-bed accumulate radioactive ions from reactor coolant. When exchange units are exhausted resin is transferred to waste-storage sump. Water used in transfer goes to contaminated-water storage. Then fresh resin is added

bed systems for makeup needs and condensate purification

silica to 0.1 ppm. This already pure water by many standards is given more treatment in polishing mixed beds. Dissolved solids finally reach the low level of 20 to 50 ppb (0.02 to 0.05 ppm). Soluble silica approaches 5 ppb (0.005 ppm). Average makeup flow is 225 gpm.

Dissolved solids and silica are removed from condensate by three large mixed-bed demineralizers and held to the same level as makeup. These polishing units are fed from bitter condensate storage and discharged into sweet condensate storage. At normal rating about 30% of the returns are treated. But the equipment can handle the entire condensate flow if the need arises.

Control of this demineralizing plant is essentially manual. But there are so many automatic features that it can almost be classed semiautomatic. All operating valves have pneumatic motor operators. They are opened and closed by manual 3-way air valves centrally located on three control panels. Indicating lights are used to signal valve position.

Meters record and totalize all flows to exchangers and points of use. Conductivity controls monitor unit performance with high conductivity automatically shutting down the plant. Flow of regenerant chemicals is definitely in the semiautomatic class. Regenerant pumps are controlled by timers with pushbutton start and automatic stop. In addition, dilution water flow rates are controlled by pneumatic instruments.

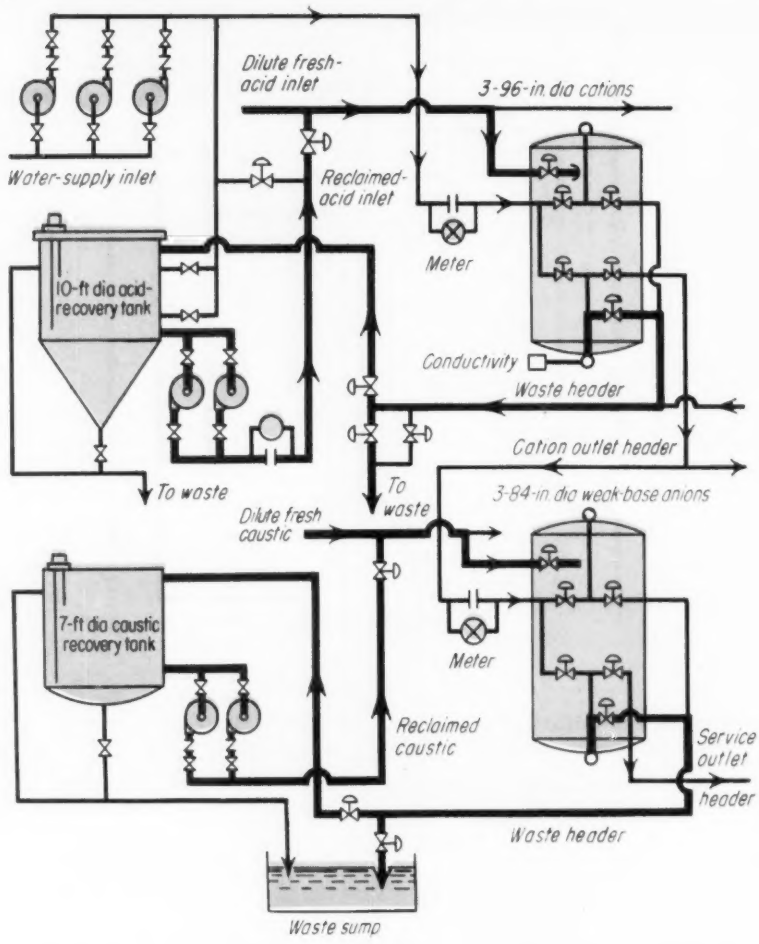
Condenser compartmentation will help pinpoint leakage to a particular tube section and distinguish it from a conductivity increase due to added chemicals. It's also possible to pump water from any one of three condenser sections through the polishing units. If one of these sections leak, it's possible to remove the contaminants from the condensate without immediately decreasing load for repairs to the condenser.

Polishing mixed-bed equipment at present is confined almost exclusively to the supercritical and nuclear fields. But there will be many more applications of this type on condensate in subcritical-pressure boiler systems. Much work still needs to be done with this equipment to find (1) upper flow rate limits (2) effect of extended high-temperature operation on exchange resins (3) effect of heavy metal pickup on exchanger life and capacity.

Nuclear power plant uses of mixed bed will also include removing radioactive ions from the coolant system. Because waste disposal is a problem, exhausted resins are removed without attempting regeneration, above. Flow from cation and mixed-bed exchangers are blended to adjust pH of water going to reactor.

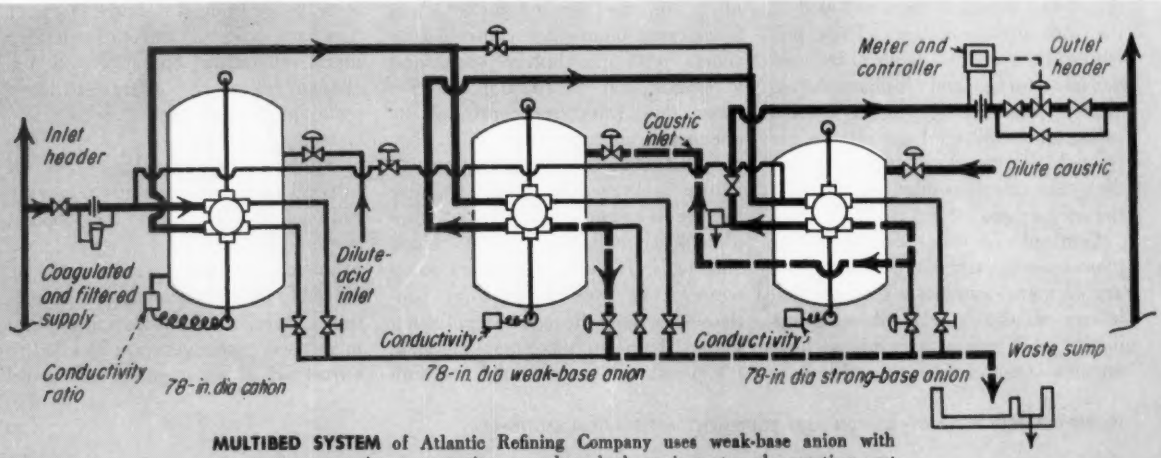
Chemical reclaiming can reduce operating costs

Demineralizing system at Weirton Steel Company has the tough job of treating Ohio River water. This plant uses 600 gpm of top-quality water for tin-plate rinsing. Raw water is first clarified and filtered. Total dissolved solids average about 200 ppm. Since silica and carbon dioxide don't affect product quality, weak-base anion material is used. Conductivity of the treated effluent is about 13 micromhos. Regenerant reclaiming system is shown on flow diagram at right. About 1100 lb dilute acid (2%) is pumped from the reclaim tank into the cation unit and out to waste. Next step is to introduce 2050 lb fresh acid (5%). Best part of spent acid leaving the exchanger is diverted to the acid reclaim tank for use in the next regeneration. Technique is the same for caustic recovery. Biggest operating problem with acid recovery systems is usually formation of insoluble sulfates from spent acid in the reclaim tank.



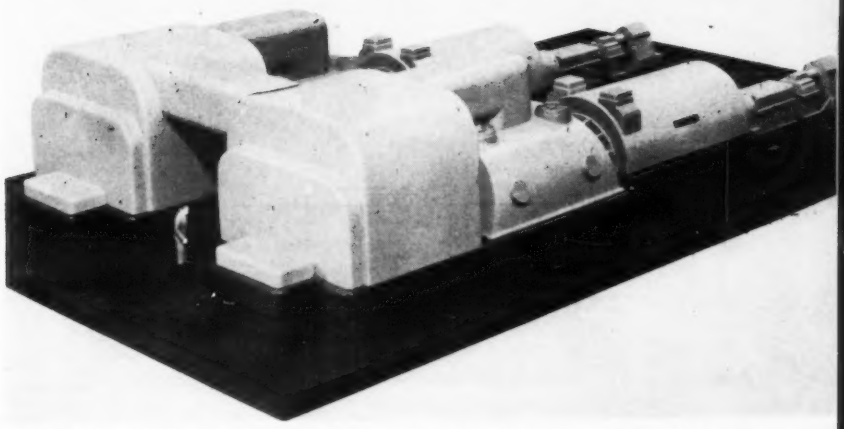
More industries will demineralize boiler-makeup and process water

Multibed system, below, gives up to 300 gpm treated water for medium-pressure boilers. Raw water has about 150 ppm dissolved solids. This is reduced to 10 ppm and 0.1 ppm silica. High proportion of chlorides and sulfates called for a weak-base exchanger ahead of the strong base. Further economies come from series regeneration. Caustic is passed through the strong base and then through the weak base before going to waste. So it's possible to regenerate the strong base before it exhausts and not waste caustic. Unused regenerant from the strong base is more than enough to regenerate the weak-base unit. Plant consists of three trains identical to the one shown and regenerated one at a time. Weirton Steel, above, and Atlantic Refining are both good examples of industrial demineralizers. Trends to improved product quality and lower operating cost mean greater demand for high-quality water. So increased use of demineralizing systems is definitely in the cards.



MULTIBED SYSTEM of Atlantic Refining Company uses weak-base anion with countercurrent series regeneration to reduce both equipment and operating cost

By N D GOVE
Westinghouse Electric Corp



MODEL of the new-design tandem cross-compound quadruple exhaust turbine which was developed to drive two 145-mw generators for Public Service Electric & Gas Co of N. J.

Cross-compound 3600/3600-rpm machine is near-duplicate of two parallel units

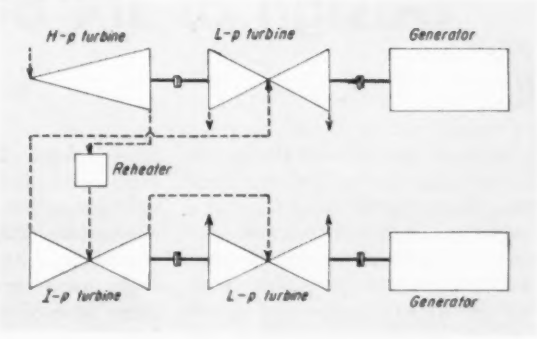
An unusual design in cross-compound steam turbine arrangement broke the surface recently. Dubbed the "cross-quad" by its designers and developed for the Public Service Electric & Gas Co of N. J., the unit departs from the 1800-rpm shaft usually associated with cross-compound machines.

This tandem cross-compound, quadruple exhaust arrangement operates both shafts at 3600 rpm. It's designed for ratings to 300,000 kw, steam inlet pressures from 2000 to 3000 psig, inlet temperatures of 1000, 1050 or 1100 F. Arrangement's principle is applicable to units to 500 mw, though this rating would require sextuple-flow exhaust.

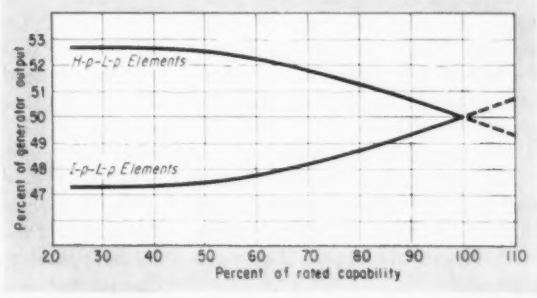
Major advantage of the 3600/3600-rpm design is the near-duplication of the two parallel turbine-generators. Only difference is that one has a h-p turbine element, the other an i-p element. Everything else—l-p elements, generators and associated switchgear—is the same for both parallel units. This saves in maintenance costs because parts common to both units can be stocked.

Steam flow is through the h-p turbine to the reheater. Taking reheated steam at the center, the i-p turbine discharges half of it to each of the two double-flow l-p turbines which exhaust to a common condenser.

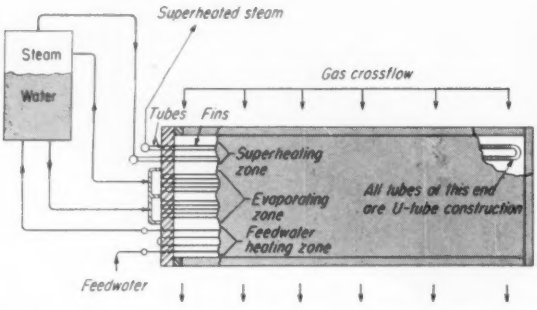
With this machine, load can be balanced between the two shafts at a selective point by the designer's proper choice of reheat pressure and entrance pressure to the l-p elements. Identical generators divide the load evenly at the rated 290-mw output. This equal division varies only slightly at lower loads. Curves, right, show load division between elements.



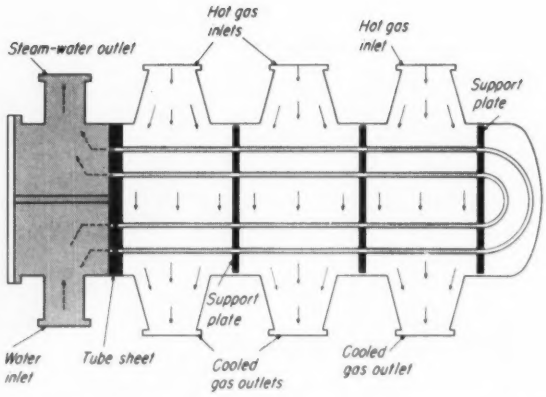
STEAM-FLOW is through h-p turbine to reheater. I-p turbine takes reheated steam at center, discharges to two double-flow l-p units



LOAD DIVISION between power shafts is equal at rated 290-mw output. Curves show that little change occurs at varying loads



1 Crossflow steam generator uses finned tubes, has economizer, evaporating and superheating sections. Gas enters from duct



2 Shell-and-tube steam generator has crossflow arrangement to produce saturated steam by cooling gas heated in a reactor

Part 2 of 2-part article shows how tubes and shells may be arranged to gain different advantages in gas-heated boilers. Special problems of radioactivity affect the . . .

By PHILIP S OTTEN
The Griscom-Russell Company

Design of six boilers for gas-cooled

Last month we explored the factors that affect the design of a steam generator heated by the coolant gas of a nuclear reactor, see "How tubes compare for nuclear reactor boilers," POWER, Jan 1958, pp 80-83. With these factors as a background we are ready to study suggested designs and recognize their advantages and limitations.

Unit design. Simplest straight-tube unit has fixed tube sheets at each end and a cylindrical shell; a good design if tube and shell metals expand equally and create no large stresses. Gas-heated steam generators seldom behave this way, so some method must care for the differential thermal expansion.

Units can have an expansion joint built in the shell or have a floating head with an expansion joint in the outlet nozzle. We do not feel expansion joints should be used if they can be avoided.

A floating head or 2-pass U-tube exchanger eliminates need for an expansion joint. These are good with water boiling in the tubes. A floating-head design with a large downcomer pipe to the floating head would be satisfactory with water in the tubes. If the primary coolant must be in the tubes, none of these designs is satisfactory with a large temperature range because of the thermal stresses in the fixed tube sheet between cold and hot areas.

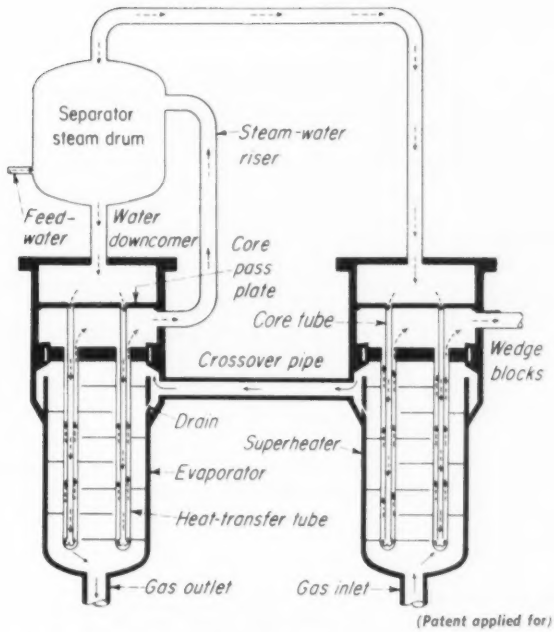
A floating head design may give stress trouble if any tube becomes plugged or if serious flow unbalance occurs at part loads. Both U-tube and floating head designs will have serious thermal stresses for large temperature differences between passes, as during start-up. A design giving individual tubes freedom to expand is recommended.

The U-tube — U-shell, bowed or Bentube, and the bayonet designs do not have these problems. In the first type the radius of bend in the closest U-tube and the feasibility of allowing one head to float minimizes the problem. In the other two units each tube expands and contracts individually.

Crossflow unit, Fig. 1, has fins perpendicular to the tubes; but the superheater would more likely use bare tubes. Gas flows through a rectangular box across the tubes from a matching duct. A light metal shield could protect the tube sheet from the hot gas flow. Feedwater-heating zone cools the gas below the saturated steam temperature. Feedwater heating and superheating zones are optional with this design.

The rectangular shell causes minimum pressure loss on the gas side and would be used with low-pressure gas. This design becomes heavy and costly at higher pressures if the flat plate sides must be stayed or ribbed. This design is economic for gas pressures up to 50 psig or when pressure containment of the shell side is external to the unit.

Rectangular sections with light sheet metal guides can be mounted inside horizontal or vertical cylinders



3 Bayonet-tube heat exchangers act as evaporator and superheater, *l* to *r*. Gas flows through crossover between two shells

nuclear-power reactors

that act as the gas containment vessel. When mounted in a vertical cylinder with the tubes horizontal we need a very large diameter tank or the surface becomes costly because of the large number of short tubes. The Calder Hall units with horizontal extended-surface tubes have vessels of 18-ft dia and 70-ft height.

Fig. 2 shows a more compact arrangement for a horizontal gas cooler. The surface has been packed in the shell in the horizontal direction, but space above and below the bundle provides for gas distribution. Fig. 3 shows a similar unit mounted vertically with bayonet tubes. This shell design with large adaptor nozzles becomes economically competitive at 25 to 150-psig gas pressures. In both Fig. 2 and 3 superheating and feedheating sections may be added from the U-tube or floating end with separate tube sheets to avoid stresses from vertical temperature gradients.

Vertical head-up bayonet design, Fig. 3, has the gas flowing outside the tubes. Bare tubes can be replaced with longitudinal fin tubes. With the rectangular or cylindrical shell of Fig. 1 and 2, a crossflow gas stream could be used. This design would use gas pressures from 100 to 1000 psig and temperatures up to 1000 F.

Longitudinally finned tubes would be economic in the evaporator up to 500 psig while bare tubes would be better at higher pressures. Dubious economic advantage of extended surface on the superheater needs evaluation for the particular conditions. Superheater in Fig. 3 has a single or uninsulated core tube and the flow in the heat-transfer tube is concurrent to the gas flow. This arrangement is preferable when: (1) the saturated steam temperature is lower than entering gas temperature (2) superheated steam outlet temperature is below gas outlet temperature from superheater.

This flow pattern reduces thermal stresses in tube sheet and at tube-sheet-to-shell juncture. Long temperature range of superheat requires an insulated core tube. Insulated core tube for superheated steam, or hot primary coolant, Fig. 6, has a simple pair of concentric tubes open at one end and separated by wires or dimples in the outer tube. The annulus of stagnant gas acts as an insulator sufficient to meet most requirements.

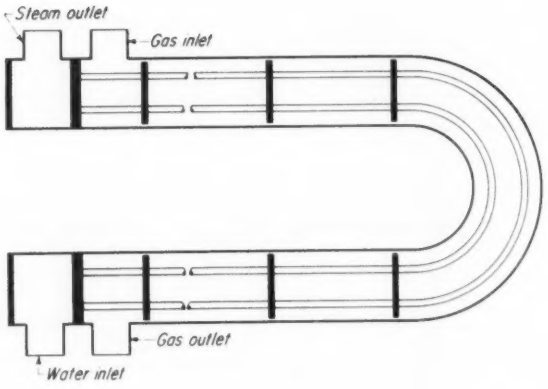
When temperature of superheated steam outlet exceeds that of the superheater gas outlet, the gas flow should be reversed so that the gas inlet is in the crossover pipe connection and the gas outlet or crossover pipe connects at the end of the shell labeled gas inlet, Fig. 3. For this rearrangement the hotter the superheated steam the less the thermal gradients at the tube sheet with a reduction of thermal stress levels. The core pass plate then carries the major thermal gradient and can be protected with a thermal shield. In addition, a small leakage across the core plate is not serious since both fluids are the same—this would only cause slightly reduced performance.

Accessibility of the heat transfer bundle gives this design an additional major advantage. If the steam generator stands in the shielded reactor compartment, the upper part of the head may be arranged within the biological shield and the entire tube bundle withdrawn up through the shield without cutting any primary coolant or steam piping. Tube bundle maintenance does not need access to the reactor compartment.

The evaporator has an uninsulated core tube acting as a preheating zone for the downcomer water from the steam drum. In this tube-side arrangement there is no likelihood of reversed steam flow as there might be for a vertical U-tube unit. A thermal barrier can protect the tube sheet or the gas flow can be reversed. If the superheater has the flow reversed, piping could be reduced by also reversing the gas flow in the evaporator.

This design can have a monitored double barrier. With tube materials of proper expansion coefficients an inert-gas-monitored barrier might be feasible. This design of steam generator, however, has not been run

Choosing right gas-cooled reactor boiler depends on balancing economics and good layouts



4 U-shell design minimizes temperature stresses but must be cut apart to replace defective tubes; good for once-through boiler

with large temperature gradients across the tube wall. An inert-gas cover with sodium-potassium alloy or sodium liquid metal monitor is feasible but not recommended. Nondrainability of the bayonet tubes is a disadvantage of this design.

U-shell design, Fig. 4, with U-tubes can work as a once-through steam generator. Making the superheated steam approach the gas-inlet temperature and the cold gas approach the inlet-water temperature reduces the temperature gradients through the tube sheets and tube-sheet-shell junction to acceptable levels. Bolted covers can have gasketed or welded diaphragm seals on the waterside of the unit for maintenance accessibility.

This design has two major disadvantages: (1) Plugging an individual tube is the only repair possible without cutting the shell end apart. Replacing tubes becomes very awkward. (2) A once-through steam generator needs extreme care to obtain very pure solid-free water to prevent scaling. It seems unwise to add this problem to others in operating a reactor at the present time.

Advantage of using a U-tube in U-shell design instead of a U-tube bundle in a single shell lies in reducing or eliminating certain thermal stresses. A standard 2-pass tube design, using U-tubes or straight tubes, may have objectionable thermal stresses in the tube sheet and heads at the separating partition in the head. Temperature difference between incoming and outgoing fluids creates the stresses.

A U-tube with a small-radius bend is about as inflexible as though the tubes were straight and fastened into a floating tube sheet. When the two legs run at different temperatures they set up high stress in the tube and tube joints. Separating the hot and cold areas in a U-shell and using large radius tube bends eliminates this problem.

Kettle-type saturated steam generator, Fig. 5, runs with high gas pressures up to 5000 psig, but moderate temperatures. Because of thermal stresses at the junction of the tube sheet and shell and on the steam face of the tube sheet, gas inlet temperature should not exceed 300 F above the saturated steam temperature for thick tube sheets. Although units with more than 600-F temperature difference have been satisfactory with moderate gas pressures, we do not recommend them where a high degree of structural reliability is needed, without running a careful stress analysis.

The high-pressure head can be sealed with (1) clamp ring and diaphragm as shown or (2) a breech-block type closure used in high-pressure feedwater heaters with either a gasket or diaphragm external seal. Tubes are free to bow to take up differential expansion between tubes and shell or between tube and tube. Tubes can be plugged or replaced without major difficulty.

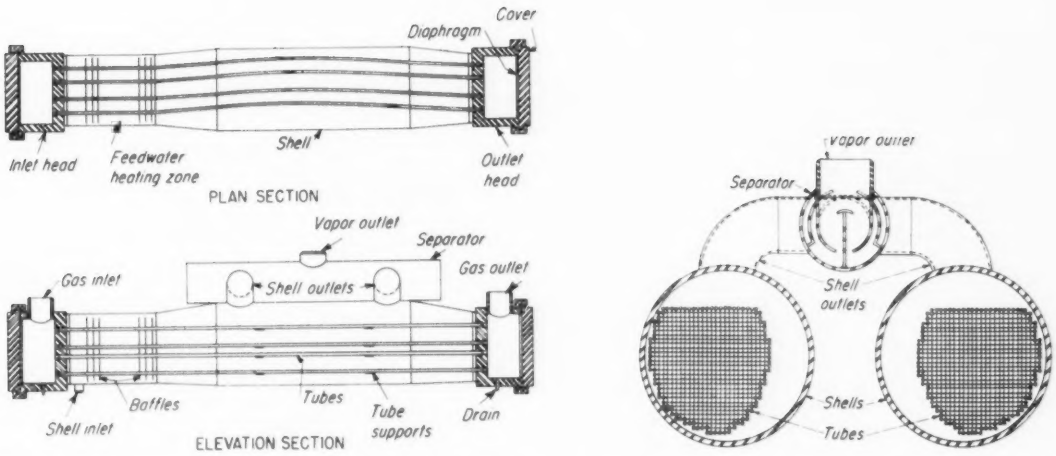
This kettle design eliminates a steam drum. The separator takes out the small amount of water entrained in the steam. The kettle design responds rapidly to load rises without surges typical of recirculating thermosyphon units. From no load to full load the water level rises only about 6 in.

Feedwater heating zone may not be needed but it helps cool the gas to or below the saturated-steam temperature. Outlet-gas temperature at part load can be controlled by bypassing feedwater directly to the evaporating section.

A bowed-tube superheater has not been attempted because of difficulties in baffle design. A Bentube steam generator has been successfully run in a liquid-metal loop and many have been used as steam generators heated by hot tar, oil and steam.

Vertical head-down bayonet type steam generator, Fig. 6, was recently designed for the following advantages: (1) To use common ferritic materials for which boiler-water treatment has been well established. (2) To avoid using austenitic steels in the early superheater stages where many failures were caused by chloride stress corrosion. (3) Water jacketing allows using gas-inlet temperatures higher than conventional.

Fig. 6 does not completely show the design in two respects: (1) Separation and drying zone above the apparent water level is about 2 ft high —separator baffles mount above this. (2) Inlet and, if wanted, outlet gas lines are completely water jacketed



5 Kettle-type saturated steam generator can pass 5000-psig gas through bent tubes to evaporate water in shell. Bowed tubes adjust for differential expansion between shell and tubes as needed. Shells function as boiler drums; separator dries steam

—this would probably extend back to the reactor.

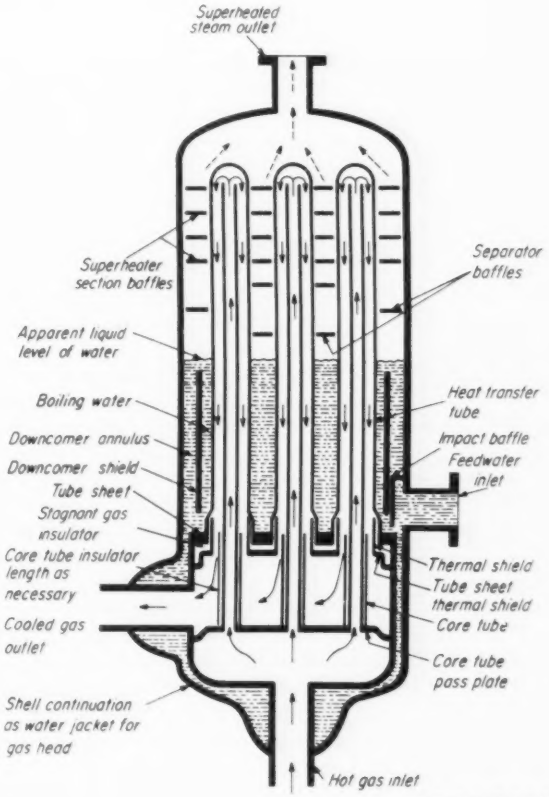
Because of heat transfer through the uninsulated part of the core tubes, we expect the inlet-gas temperature to drop to a level allowing the containing heat-transfer tube wall thickness to be designed according to ASME Code stresses. The flow path minimizes thermal stresses across the tube sheet while the thin core-tube-pass plate attaches flexibly to allow differential radial growth. Stagnant gas shields reduce the tube-sheet and core-pass-plate thermal stresses.

Bayonet superheaters have run successfully. An additional test unit of horizontal bayonet tube superheater and evaporator in seperator units is scheduled for test. Units will be heated with liquid metal and have an inert-gas-monitored duplex tube.

Bayonet design can be compartmented with small bundles or group of tubes inserted in a large shell. Complete bundles can be isolated without raising stresses in the large shell by major temperature gradients. Bundles can be withdrawn by separating unit above gas outlet line. This type can be made for a totally submerged saturated steam generator if superheat is not needed. Separate superheaters can be used if gases are hot enough. Water jacketing the superheater head would not be needed because of the combination design shown in Fig. 6.

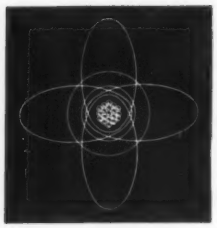
Water solids must be carefully controlled to reduce solid buildup in the separator zone. Control need not be extreme if regular cleaning periods are established. Water-soluble deposits can be removed by raising the water level to wash them out. A completely volatile oxygen scavenger should be used with this unit.

Careful water-level regulation is not needed if gas temperature is not high enough to make a tube fail. A 3-way control should be enough with possible addition of a small water drum to offset a feedwater pump failure. Enlarging shell at the apparent water level would do the same control job.



(Patent applied for)

6 Vertical head-down bayonet heat exchanger has water-jacketed gas inlet and outlet to allow using high-temperature gases



Nuclear notes

By B G A SKROTZKI, Associate Editor

Model C Stellerator will be built for Princeton University and AEC by the C Stellerator Associates. This organization has been formed by Allis-Chalmers Manufacturing Company and Radio Corporation of America to pool their heavy-power and electronic know-how. The Stellerator will produce a gas discharge generating temperatures of millions of degrees to yield data important in designing fusion-power reactors. Unit is expected to start running in 1960.

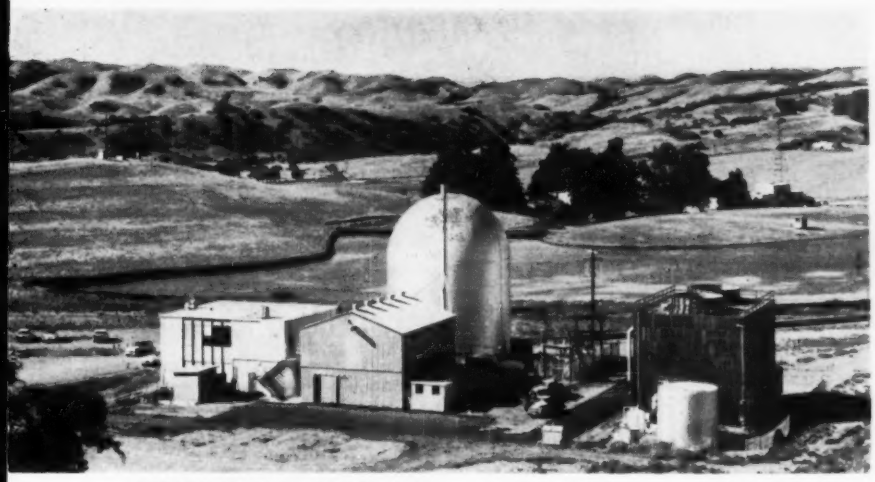
Homogeneous Reactor (HRE-2) at Oak Ridge National Laboratory went critical on Dec 27, 1957—it's the sixth one to start in the U.S.A. The 5-mw heat output will be dumped to atmosphere for the time being. The reactor has a core filled with a heavy-water solution of uranyl sulfate surrounded by a blanket containing heavy water as the initial loading. Plant has chemical-processing equipment for purifying the irradiated fuel solution by continuously removing solid corrosion and fission products.

Full power output of 60,000 kw was produced by Shippingport Plant of Duquesne Light Company on Dec 23, 1957. At this net output the reactor produced more power than any other individual reactor in existence. Of the 68 mw produced by the turbine-generator, 5.5 mw ran three of the reactor circulating pumps and 2.5 mw powered the other station auxiliaries.

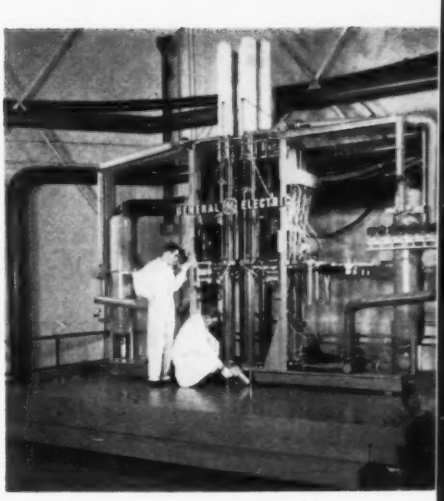
Bootstrap operation of Experimental Boiling Water Reactor (EBWR) at Argonne National Laboratory of AEC points to hopeful way of reducing atomic-power costs. The 20-mw heat-output reactor produced 50 mw under stable operation with natural circulation through the core. The 5-mw turbine-generator produced 6.25 mw and the excess steam by-passed to the condenser. Designers think core could produce even more steam. With modifications and more fuel the reactor possibly could produce 100-mw heat or about 25-mw electric.

Large-scale homogeneous reactor plant has been proposed for construction by the Pennsylvania Power & Light Co and Westinghouse Electric Corp to the AEC. This responds to Power Demonstration Reactor Program (PDR) announced by AEC in Jan 1957. A plant of 70- to 150-mw capacity would use thorium-uranium cycle. Work started in 1955 by PP&L and Westinghouse has cost them $5.5 million so far. Baltimore Gas & Electric Co recently joined the project. Proposal asks for $7.3-million research assistance to be followed by $18 million for construction and operating assistance during first five years. A 150-mw plant was estimated to cost $380 per kw.

Gas-cooled heavy-water-moderated reactor for high-temperature steam has been proposed by East Central-Florida West Coast Nuclear Group for construction under AEC's PDR program. A 50-mw-electric prototype to be built in Florida would precede a full-scale 200-mw plant. Smaller plant would use slightly enriched uranium, larger would use natural uranium. Proposal asks research assistance from AEC and waiver of use charges for fuel and heavy water during first five operating years; starting date—1963. East Central Group includes: AG&E Service Corp, Cleveland Electric Illuminating, Columbus and Southern Ohio Electric, Dayton P&L, Indianapolis P&L, Louisville G&E, Ohio Edison, Pennsylvania Power, Southern Indiana G&E, Monongahela Power, Potomac Edison, West Penn Power Cos. Florida West Coast includes: Tampa Electric Co and Florida P&L Corp.



DOMED CONTAINMENT VESSEL houses reactor furnishing steam to conventional turbine-generator in adjacent building. Note control building, *left*, cooling tower, *right*



INTERIOR of containment vessel. Men are on upper shield near control-rod drive

Vallecitos atomic power plant goes on the line

Another important step along the road to proving the economic feasibility of nuclear power was taken last fall at the General Electric Company's Vallecitos Atomic Laboratory near Pleasanton, California. Control rods moved out of the reactor, and a nuclear-powered generating station went "on line" — sending 5000-kw electricity flowing through the Pacific Gas & Electric Company's transmission system.

The reactor is a prototype of the largest all-nuclear power station yet scheduled in the U.S.—the 180,000-kw Dresden Station to be completed in 1960 near Chicago. Furnishing steam to a turbine-generator owned and operated by PG&E, the reactor's significance lies in the fact that it's producing this country's first privately-financed atomic electric power.

Known as the Developmental Boiling Water Power Reactor, the Vallecitos unit is the outgrowth of plans laid by GE people in 1955 for a small plant to be used to develop operational data which would assure success of the full-scale Dresden reactor.

The DBWR is a direct boiling type reactor—steam being generated within the reactor vessel—using ordinary water as both moderator and coolant. Housed in 3⅜-in.-thick steel pressure vessel, the reactor's present core consists of 104 stainless-clad plate type fuel elements containing a total of 23 kg U-235. Later in the development program the reactor will use low-enrichment type fuel elements containing up to several tons of uranium oxide. Seven electrically-driven plate type rods composed of boron-carbide and stainless steel control the reactor.

In operation (the reactor is equipped to employ either natural or forced circulation), water enters the bottom of the pressure vessel and is heated as it rises through the reactor core. Steam produced leaves at the top of the vessel and passes directly to the conventional PG&E turbine-generator. Steam conditions are 1000 psi, 545 F. The turbine exhausts to a condenser from which the condensate returns directly to the reactor.

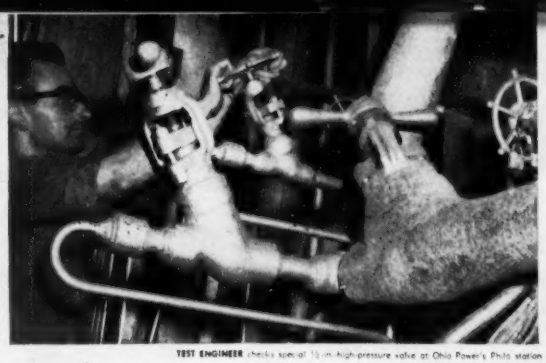
A major feature is the system's ability to simulate dual-cycle boiling reactor operation. In a dual-cycle boiling reactor — the type which will power the Dresden Station—hot water is taken from the reactor vessel at the top of the core. The water is sent through a heat exchanger, generates steam at lower pressure and temperature than that produced in the reactor itself. In normal dual-cycle operation, this steam would enter an i-p stage of the turbine for additional power. However, in the simulated operation, the secondary steam generated isn't used in the turbine, but is exhausted to the atmosphere.

The 60-ton reactor pressure vessel, together with the control rods and their drive mechanism, are housed in a dome-topped cylindrical steel containment vessel 48 ft in diameter and 100 ft high. Approximately 35 ft of the vessel is underground. Concrete shielding, up to 8-ft thick, surrounds the reactor and its 80-ton upper shield consists of 18-in.-thick steel slabs. The containment vessel, tested to 56 psig air, is hermetically sealed during operation to avoid any possibility of radioactivity escape to the atmosphere.

Controls for the reactor and generating plant are consolidated, by over 100 miles of connecting wiring, in the adjacent control-and-office building. From here, closed-circuit television enables operators to see inside the containment vessel and all instruments installed there.

Here's what engineers are saying about . . .

Majority of comments fall into three broad categories. One group calls for more research and development. Another favors an intermediate-pressure standard. And the third leans toward a 4500-psi series now



TEST ENGINEER checks special fitting on high-pressure valve at Ohio Power's Philo station

Now, a 4500-psi standard for valves?

- High-pressure boilers over 2500 psi call for special, expensive valve designs. Many other industries also use valves at pressures higher than existing ASA standards
- Industry-wide standards mean dollar savings for all concerned . . . even those whose need is infrequent and small
- Critical pressure creates a sort of "no man's land" in boiler development. So there may never be any great demand for valves in a 3000-psi range
- Recent survey of prominent engineers revealed strong preference for a 4500-psi standard. It has added advantage of numerical simplicity with technical practicality
- On the following pages, W F Crawford urges adoption of a 4500-psi standard series now

by W F CRAWFORD, President Edward Valves Inc, subsidiary of Rockwell Manufacturing Co

POWER • DECEMBER 1957 • ENGINEERING AND MANAGEMENT SECTION 100

There is some feeling that more research and development is needed

D J BERGMAN, Chief Engineer, Universal Oil Products: Perhaps it is too soon to arrive at a final decision on flange thicknesses for a 4500-psi series, but before settling on the same design used in the past a thorough study should be made of a paper entitled *Experimental development work with 15,000 psi well head connections* by R C Brooks. (ASME Petroleum Division, Paper 57-Pet 8, Tulsa, September, 1957.)

As a result of some experimental work using the pressure-sealing characteristics of the high-pressure ring joint it was possible to cut the thickness of a 15,000-psi flange to about half a standard 10,000-psi flange and be more sure of its tightness.

J J KANTER, Directing Engineer, Research & Development, The Crane Co: There is little doubt that pressures requiring valves beyond the 2500-psi class will become more frequent and require entirely new valving concepts and valve designs. Whether current valve needs beyond the 2500-psi class can best be met through the creation of new standards rather than increase of ratings on present standards is a matter for careful examination by the various standards-making groups in the valve and piping fields.

Our valve engineers believe that it is not yet clear that a standard for a pressure class as high as 4500 psi can be approached. There may be a better case now for concentrating standardization studies in the range somewhere midway between 2500 psi and 4500 psi, but it seems somewhat premature to attempt codification of equipment for a 4500-psi class. The projects currently requiring such equipment are rather limited and perhaps experimental in character. Before a worthwhile standard for 4500-psi-class valves can be written much further development of materials and high-pressure design concepts must be accomplished. Rather than confuse the problem by attempting to project the rather inadequate precedents of the lower-pressure-class standards into this range, we recommend for the time being that a 4500-psi valve class and increased ratings in the lower-pressure series be considered as a subject for research and development rather than standardization.

M H KUHNER, Vice-President Engineering, Riley Stoker Corp: We may be a little premature in trying to establish rigid standards for supercritical-pressure valves at this time. Would it not be better to gain some degree of service experience with the high-pressure valves so far in use? At present there is only one power plant operating on and off on supercritical pressure. We still have very much to learn about the behavior of water and especially high-temperature steam at supercritical pressures. I don't feel that the final answer for the design of a valve suitable for supercritical-pressure service consists simply of adopting the conventional construction of the 2500-psig pressure standard with thicker valve body to take care of the higher pressure and body and trim of stainless steel to take care of the temperature.

The proposed valve-body thickness for the 4500-psi standard series illustrates glaringly that we will have valve bodies of almost ridiculous thicknesses.

We must realize that there is a practical limit in wall thicknesses for valve bodies as there is for piping and tubing. If the limit is exceeded the structure becomes weaker the thicker the wall. The internal stresses set up by the temperature difference between heated and unheated surfaces of thick-wall vessels may gradually destroy the metal structure.

I certainly can see no need for valve sizes larger than possibly 12-in. nominal for the 4500-psi class. I doubt that anyone would consider steam lines of larger nominal diameters for supercritical-pressure design. It is more economical to use two, three or more lines of smaller diameter than one line sized for the total flow.

Others believe the next new standard should be in a 3500-psi range

G W KESSLER, Chief Engineer, The Babcock & Wilcox Co: We believe the jump from 2500 to 4500 psi is too much and rather than to use a percentage increment in pressure it is better to consider a relatively fixed pressure differential. We have gone from 1500- to 2500-psi standards and if we continue to use a thousand-pound increment our next standard should be 3500 psi, followed by a subsequent standard at 4500 psi. If we go from 2500 to 4500 psi in one step, the cost of many units might be heavily penalized. We certainly expect this to be the case when using once-through-type boilers at subcritical pressures.

C D WILSON, Chief Turbine Design Engineer, Allis-Chalmers Manufacturing Co: There is a definite need for a standard series of chrome-moly valves having a pressure-temperature rating suitable for 2400 psi, 1050 F and also for 3500 psi, 1050 F. Whether a new 4500-psi standard series is the most economical solution is questionable since the physical size of the valves and the cost may be much greater than necessary. A tabulation of overall dimensions and costs for valves designed for 3500 psi, 1050 F as compared to the proposed 4500-psi series would be helpful in reaching a conclusion.

G B WARREN, Vice President & Consulting Engineer, General Electric Co: We are inclined to believe that a new pressure standard higher than 2500 psi is in order, but we are questioning whether it should be as high as 4500. . . . Some subsequent turbine orders for supercritical steam conditions have been at lower pressures than the very-high pressures of the first once-through boiler designs, i.e., down to about 3500 psi, largely because of economic reasons. That is, at the moment it appears that the cost of going to higher pressures than this outweighs the capitalized advantages. We must, therefore, go through a period of consolidation of our gains before doing more. . . . If our interpretation of this trend is correct, then the 3000 to 3500 psi installations might be unduly handicapped with costs if the next valve standard is as high as 4500 psi. . . .

Although present lower pressure standards differ about 66%, it is quite true that the gains for a given percentage increase in pressure are somewhat more in the lower than in the upper pressure levels. So it is rather logical to feel that succeeding steps from here on up should be on a lower percentage basis. We recommend that if a new standard is established, it should be suitable for the 3000 to 3500 psi region at 1050 F, rather than 4500 psi. This is, of course, a very indeterminable level because of the variation in materials, temperature, etc. . . . It seems to us that some cognizance should also be taken of the time element at which such valves are subjected to full design pressures and temperatures. For example, many valves designed for high temperatures and pressures are such things as drain valves that probably never operate at full temperature for more than a few hours per year, and yet if built in accord with the normal standards may be over-strong and over-costly for their actual service.

F A RITCHINGS, Chief Mechanical Engineer and S CROCKER, Mechanical Engineer, Ebasco Services, Inc: Table of pressure-temperature ratings in Mr Crawford's article does not conform to primary service ratings given in ASA B16.5-1953. If these nonstandard ratings apply to Edward valves of special thickness it should be so stated. Another discrepancy is giving 1¼ Cr- ½ Mo the same 4500-psi rating at 1050 F as that shown for 2¼ Cr-1 Mo. These materials do not have the same allowable stresses at 1050 F under the codes.

Table of valve body thickness is based on the statement that "The valve designer starts with the nominal outside diameter of existing ASA pipe and calculates the internal bore. This internal diameter must match the proposed high-pressure valve design." While this may apply to standardized pipe stocked for low to medium pressure, its validity is questionable for large high-pressure pipe forged, turned and bored to special dimensions for each particular job. Let's start from scratch and see if there isn't a better method for both the piping designer and the valve manufacturer.

For pipe in this category, the designer starts with a series of flow computations to find the bore that gives a reasonable pressure drop. With high-pressure pipe beyond the schedule-number series wall thickness is then calculated. This fixes pipe OD. The ID is not calculated with respect to an arbitrary OD as assumed by Mr Crawford.

In selecting the right capacity valve for any given job, it would seem that bore and port area should govern, rather than what the outside diameter of the casting happens to be.

In joining the welding ends of the large valves and pipe, there is a definite advantage to matching the bores rather than outside surfaces. Valve body thickness is

usually heavier than pipe wall for several reasons including the shape factor and casting-quality factor. Also valves are often designed for a higher pressure or temperature than the pipe. So it's necessary to taper valve body thickness near the welding end to match pipe wall thickness. By machining a taper on the outside wall of the valve body the bores of pipe and valves can be designed to coincide without resorting to internal flares, offsets and the like. Anyone who has been confronted with the ugly problem of making a well-designed weld between offset bores will appreciate the importance of this feature.

For small pipe with an ID less than 2½ or 3 in. Mr Crawford's approach is more applicable. Very likely this size pipe for supercritical pressure can be manufactured and stocked to advantage using an extension of the schedule-number system. Since these sizes will probably be used with valves and fittings having socket welding ends, there is good reason here for standardizing on OD rather than the bore. . . .

While we agree with the objective of extending standardization to higher pressures, Mr Crawford should consider altering his specific proposals to better suit the overall realities of the problem. As far as large pipe is concerned, his analysis is based on the assumption that pipe for supercritical pressures will be mass-produced in accordance with an extension of the schedule-number system. More likely it will be produced in limited quantities to suit individual needs. There is also evidence that the existing 2500-psi standard should be "beefed up" to 3000 psi as well as establishing the new 4500-psi standard series.

Undoubtedly further modifications of approach will be suggested by others. With all these ideas before them the various standardization committees concerned should be able to come up with a logical solution suited to the special conditions of high-pressure power piping.

T T FRANKENBERG, Mechanical Engineer, American Gas and Electric Service Corp: While there were some so-called 4500-psi valves used on the Philo supercritical unit of the Ohio Power Co, they were actually 2500-psi forgings bored to smaller internal diameters. The steam conditions for this unit were 4500 psi at 1150 F but the only valves operating under these conditions were those on relatively small connections for drains and instruments. We adhered to the practice established some 15 years ago on single-boiler units of omitting any shutoff valve between the steam generator and the stop valve furnished with the turbine. The fact that in many cases there will be no major valves on the main steam line means that the power industry will probably not experience the "no man's land" in the region of 3200 psi which was referred to in the original article. We are now designing two 450-mw units to operate at supercritical conditions of 3500 psi and 1050 F. . . . The present 2500-psi standard meets the requirements of the feedwater system, and again the only valves being used in the steam line will be some small ones for drains and instruments. This does not seem to justify the establishment of a 4500-psi standard at this time, and there is some doubt in our minds that this is the pressure that will meet the majority of needs in the future.

It's very possible that the next level above the present standard should be 3500 psi or even 4000 psi. A 3500-psi rating would cover all steam applications at this pressure up to 1050 F with ferritic materials, and to higher pressures and temperatures with austenitic steels. In the range of feedwater temperatures the 3500-psi rating would be good for 6400 psi at 600 F, which should be ample feed pressure for supercritical units.

Our concern is that for the small increases over the 2500-psi rating that will probably be the next plateau in the supercritical design range we should not be faced with valves that are excessively heavy and costly. In view of the problems encountered with thermal shock after tripouts or even in the normal starting of large units, we feel that any increase in wall thickness over that actually required would not only be uneconomic, but possibly add to operating difficulties with the unit. We believe future needs are uncertain, and in setting up design ratings to cover them we should not overshoot and adversely affect the units of today. It is our understanding that a manufacturers' group is working on new standards and that ASA B16 Subcommittee 3 has the establishment of new standards under active study. . . . Our comments are intended to be no more than a helpful catalysis to the function of the responsible groups.

For maximum benefit many favor adopting a 4500-psi series now

C A DAUBER, Director of Civil & Mechanical Engineering, The Cleveland Electric Illuminating Co: I was assigned to a task force of ASA B16 Subcommittee 3 to study the merit of a new valve series above 2500 psi. . . .

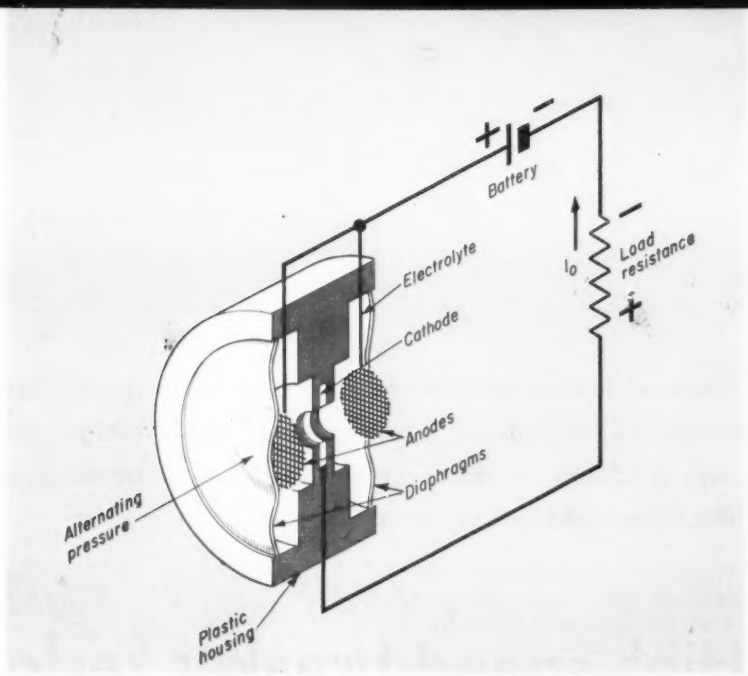
At present, the pattern in the power industry is that on certain services the limits on 2500-psi ratings are being approached, and in some cases surpassed. An example is boiler feedwater-discharge piping on supercritical boilers where pressure may exceed 5000 psi at a temperature of 550 to 575 F. Present 2500-psi rating for this service is not adequate. . . .

The power industry and (*Continued on page* 202)

In reply W F Crawford says . . .

it was both gratifying and reassuring to review the comments and criticisms resulting from the December POWER article proposing a 4500-psi standard for valves of flangeless construction. That so many well-informed engineers took the time to study the proposals and prepare comments is indicative of the extent of interest in the subject. Our sincere appreciation is extended to all

(*Continued on page* 212)



VARYING PRESSURE applied to device forces ions in solution to contact platinum electrodes. Reaction releases electrons, thus causing an increase in current flow to the external circuit

Energy transducer appears promising

For years the basic dynamic elements in electronic circuits have been vacuum tubes. More recently the vacuum tube has been replaced, in some cases, by the transistor. Now the *solion* (coined from *ions* in *solution*) is looked upon by some as a most promising addition to the electronic-component family. And at low frequencies it may prove more efficient than the transistor.

Unlike tubes and transistors, the solion utilizes ions in solution. When an alternating pressure is applied to the device, resulting electromechanical-action releases electrons. This action causes an increase in current flow in the external circuit. In brief, alternating mechanical pressure is converted into an electrical output.

Small, low-voltage cell supplies energy to accomplish the conversion. Quiescent power drain from the battery shown in above sketch is about 15 microwatts. Under conditions of maximum drive this might increase to one milliwatt, with a corresponding power output of 0.9 milliwatts. Cell potential is one volt or less.

Operating principle hinges on the oxidation-reduction action involving iodine in solution. In the static state iodine in solution close to the orifice cathode is reduced (acquiring electrons from cathode metal) while iodine in vicinity of anodes is oxidized (giving up electrons to anode metal). This simple action establishes a small static current through the external circuit called the diffusion current. It is limited by electrode area and iodine's diffusion coefficient.

As an alternating pressure is imposed on the diaphragm, electrolyte will be pumped through the orifice, bringing new ions into cathode vicinity. This action of sweeping new ions into cathode area causes a correspondingly larger increase in current through circuit.

Applications are difficult to pinpoint at this stage in solion development. Work now being carried out jointly by National Carbon Co and Texas Research Associates indicates that a single solion may some day replace a complicated circuit assembly consisting of resistors, capacitors, inductances and tubes or transistors.

Solions at their present state of development have limitations in their applications as circuit components. They are inherently low-frequency devices, usually operating best in a range from a fraction of one to 10 or 20 cps. And being electrochemical devices, most solions are temperature sensitive. This introduces problems when the ambient temperature varies widely. Most such devices are also affected by vibration and acceleration. These latter characteristics may prove useful in devices designed to take advantage of them.

Their ability to perform mathematical operations should make solions useful in analog computers where typical operating frequency is about one cps. Process-control instrumentation, where the operating frequencies are well suited to the solion's speed of response, also look attractive.

Naturally, they are suitable for devices designed to totalize exposure to sound, light, heat and other radiations. In missiles, solions will find application as accelerometers and in inertial-guidance systems.

In short, their small size, light weight and low power consumption make them candidates for portable equipment use — particularly in devices that must operate unattended in remote locations for long periods.

By D DALASTA and S DURAND, Allis-Chalmers Manufacturing Co

When ac motors are disconnected from line trapped flux causes residual voltage at terminals. Residual voltage decays gradually as motor decelerates. Out of phase with line, it can add to line voltage, so that . . .

High-speed breaker reclosing can put abnormal stresses on your motors

High-speed closing of bus-transfer tie breakers or reclosing of motor contactors during electric power system disturbances can cause overvoltages to be applied momentarily to motors. This can be illustrated by means of polar diagrams which show the vector percent value and phase angle of residual voltages on motors in comparison to the system voltage at the instant of reapplying power after a short outage.

In an ac-network calculating-board study it is possible to simulate the characteristics of an induction motor subjected to switching or fault transients in the system. By means of step-by-step calculations and voltage and phase-angle measurements, an analysis of the performance of motors during a very short system disturbance can be made. Data of this type when plotted in polar-diagram form, p. 91, illustrates the magnitude of over-voltage and consequent higher-than-normal accelerating current stresses that can be applied to a motor.

For better protection against this danger, motor control can be modified in various ways. The advantages and disadvantages of protective schemes are dependent upon obtaining positive protection at higher cost or improved calculated-risk protection by means of lower dropout voltage and slower dropout time of contactors at little or no extra cost of the motor-control equipment.

Ways in which power can be momentarily interrupted and then quickly reapplied to motors include:

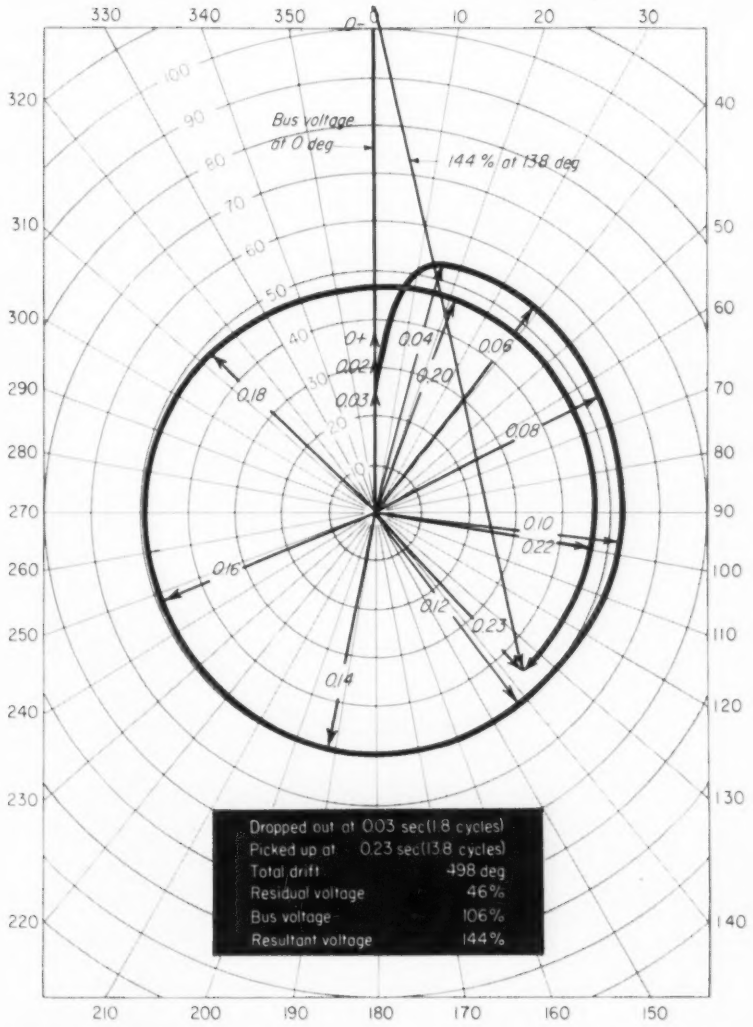
(1) In a power-generating plant, auxiliary-drive motors supplied through circuit breakers are often transferred through a tie breaker from one auxiliary bus to another. During this transfer operation, the motors may be disconnected from a power source for periods less than a second.

(2) During a system fault or switching disturbance, voltage may dip to a low value where contactors for motor control drop out. If these contactors are operated with two-wire control circuits such as from pressure or float switches they will automatically reclose on restoration of voltage. Or, if these contactors are operated with three-wire control circuits and are equipped with time-delay undervoltage devices, they will reclose if power is restored before the "time-out" setting of the timing device. Since a fault to part of a power-distribution system can be cleared by circuit-breaker action and voltage re-established to the rest of the system within about one-tenth to two-tenths of a second, the time during which motors are disconnected can be very short.

(3) In high-voltage transmission systems with circuit breakers equipped with first-shot instantaneous-reclosing relays, power can be interrupted and reapplied at very high speeds to clear circuits hit by lightning strokes. Also, high-speed switching of lines can cause fraction-of-a-second outages.

(4) An operator can push a "stop" pushbutton of a contactor and immediately thereafter push the "start" pushbutton to disconnect power to a motor only momentarily. Or, in a similar manner, he can jog a motor not designed for jogging service.

Rotor flux is trapped when power is interrupted to an induction motor, and decays with time to induce a residual voltage in the motor windings. This residual voltage will decay in a few cycles in small motors but in large machines it may require from one to more than five seconds to reach zero value. In this time, if a motor is reconnected to a power system and if, at the instant of reconnection, the residual voltage is about 180 degrees out of phase with the system



RECLOSURE AT 138 electrical degrees out of phase with bus voltage produces terminal voltage 144% of normal bus volts. Seconds after dip are shown on vectors

voltage, the resultant voltage may be considerably above the normal design rating for the motor.

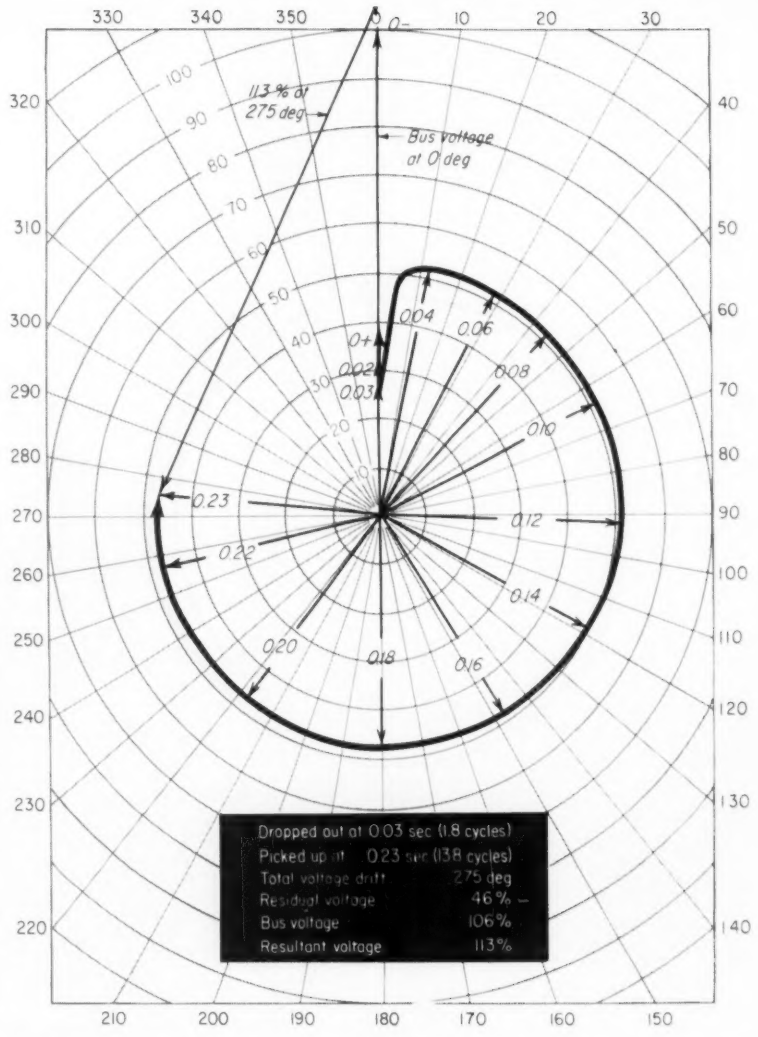
Polar diagrams were drawn from data obtained in an ac-network calculating-board study to illustrate the importance of the magnitude of the residual voltage and the phase-angle of this voltage at the instant of reconnecting motors to a system. In such a study, the design and loading of motors can be simulated to a fair degree of accuracy and the voltage and phase-angle at which they are connected to a power system can be measured. Then, on disconnecting motors from the system, the deceleration or change in slip angle in relation to the power system can be followed and, also, the residual voltage and its rate of decay at the motor terminals can be determined. Thus, polar diagrams drawn from this data give an indication of what the phase angles and residual voltages in relation to the power system can be when the motors are reconnected to the system.

In a board study of an industrial ac power system, a fault was applied to one bus. This resulted in voltage dropping almost instantly to about 30 to 50% of normal values on other busses in the system. Voltage and phase-angle measurements were made at 0.02-second intervals in accordance with step-by-step calculations of motor-interval angle changes made after each set of readings. It was assumed that a circuit breaker would clear the faulted bus from the system in about one-tenth second, so the fault was removed after this interval. This allowed voltage to recover very quickly throughout the rest of the system, and for motors that had been disconnected during the fault to pick-up in accordance with the reclosing speed of their contactors.

From typical data on contactor dropout and pickup values, 440-volt motor contactors will open their contacts within a cycle or two when voltage drops below about 50% value (some contactors will drop out when voltage dips only 15% to below 85% of normal value). These contactors will pickup and reclose in about three cycles when voltage is restored to above 85% of normal value. Standard high-capacity air-break contactors for 2300-volt and 4000-volt motors with magnets supplied with rectified dc power will not drop out until voltage dips to below 40% of normal value. The contacts on dropout will part in about 3 cycles. The pickup time when voltage is restored to above 75% value is about 13 cycles on a 60-cycle system until contacts touch. By using this data, motors represented in the system study were disconnected and reconnected dependent upon voltage conditions at the busses of substations from which they were operated.

Polar diagrams for typical motors from data obtained in this system stability and voltage study illustrate how overvoltages can be applied to motors when contactors drop out and reclose after a momentary voltage disturbance in the power system. Polar diagrams are particularly useful in showing the relative vector angles of the residual voltage of induction motors at various time intervals in relation to the system voltage.

The polar diagram, p. 91, represents the conditions that could occur



RECLOSURE AT 85 electrical degrees displacement from bus voltage produces only 113% of normal bus volts though reclosing voltage was same as in p 91 diagram

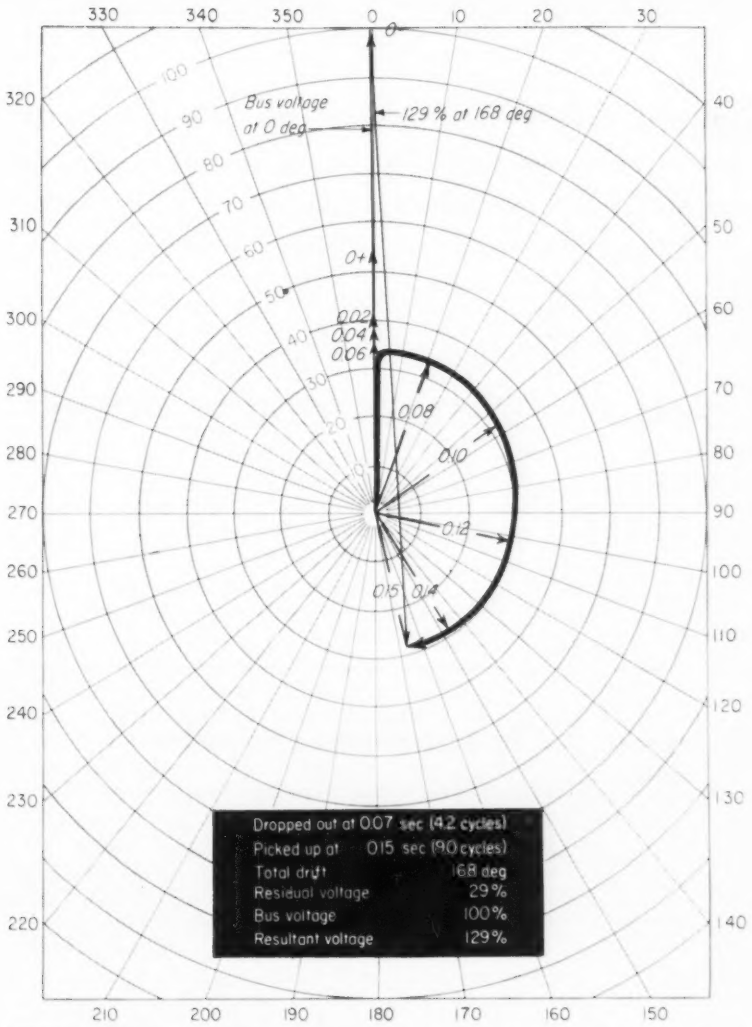
on a large slow-speed induction motor during a very short outage such as one caused by a nearby fault on a power system. In this polar diagram, the system voltage is represented by the vertical vectors on the zero-axis line. At time zero minus (0–) just before a fault is applied, the system bus voltage to which this 2300-volt motor is connected by means of a contactor is shown equivalent to normal 100% value. Just after the nearby fault on the system at zero plus (0+) time indication, the bus voltage has collapsed to below 40%. At 0.03 second, the contactor drops out because of the low voltage to its magnet coil. The trapped rotor flux causes the residual voltage at the motor terminals to rise to a value of about 60% at 0.04 second when it is disconnected from the system.

Residual voltage decays during the time the motor remains isolated from the system, and the motor starts to decelerate in speed. The decay rate is such that it would take about two seconds for the residual voltage to reach zero value. However, in the very short interval of time of about 0.2 second that it is free of the system, the residual voltage decays to only 46% of normal operating voltage. At time 0.23 second it is evident that the residual voltage angle is out of phase with the system voltage angle by 138 electrical degrees. Also, because the nearby fault in the system has been cleared by a circuit-breaker opening at about 0.11-second time, the system voltage has recovered, and actually has overshot in voltage to about 106%. Thus, when the contactor recloses at 0.23 second, it is seen that a voltage vector of 144% is momentarily applied to the motor terminals. This is considerably above the maximum momentary voltage (125%) many motor designers set as a desirable limit.

A motor subjected momentarily to such an overvoltage with resulting high accelerating current may not fail. However, stresses applied to it at this time might cause loosening and chafing of coils which could result in later unexplained failure of the motor. Undue shaft stress also results, and can cause damage.

Phase angle at which reclosing occurs determines magnitude of resultant voltage. Polar diagram, p 92, is for different motor than previous example. Residual voltage is the same (46%) at time of reclosure (0.23 sec), but phase angle is different (275 deg). Resultant voltage is only 113%, within the maximum safe value, because residual-voltage phase angle is only 85 electrical degrees from the system voltage angle when the contactor reclosed. Motor on which this polar diagram is based is a higher-speed motor than the one used for polar diagram, p 91. The rate of residual-voltage decay for high-speed motors is less than that for slow-speed motors. If reclosing had occurred at any of several instances later when close to 180 deg out of phase, an overvoltage above 125% could have been applied to the motor windings.

Advantage that is gained when the contactor connecting a motor to a power system does not drop out almost instantly when voltage sags is illustrated in polar diagram, p 93. In this diagram, the motor was connected to a substation more remote to the fault on the system than the motors of the previous diagrams. As a consequence, the voltage did not decay to the dropout value of the


Bus voltage at 0 deg
129 % at 168 deg
Dropped out at 0.07 sec (4.2 cycles)
Picked up at 0.15 sec (9.0 cycles)
Total drift 168 deg
Residual voltage 29%
Bus voltage 100%
Resultant voltage 129%

LOWER RESIDUAL VOLTAGE at dropout, result of smaller voltage dip, produces only 129% normal bus volts though reclosure occurred at 168 electrical degrees

contactor until after 0.06 second. At the time this motor was disconnected from the system, there would be less trapped rotor flux and therefore a lower resultant residual voltage. Even though the contactor reclosed when the residual voltage was nearly 180 degrees out-of-phase with the recovered system voltage, the resultant voltage of 129% is only slightly in excess of the desired maximum (125%) value. This diagram is typical of possible behavior of small general-purpose squirrel-cage motors for 440-volt service. Due to the more rugged construction and shorter length of end-turn windings, they can withstand overvoltage more readily than large induction motors.

Timing of contactor reclosing to permit contacts touching only when the residual voltage is nearly in phase with system voltage obviously would be difficult to control. Contact travel time, voltage to contactor magnet and other factors would enter into any control scheme to provide such contact-retouch accuracy. Also, it is seldom desirable to specify motors of special design to withstand locked-rotor torque stresses due to applying high overvoltage to the windings. Thus, other simpler solutions to prevent overvoltages on motors are desirable when high-speed reclosing of contactors or tie breakers can occur.

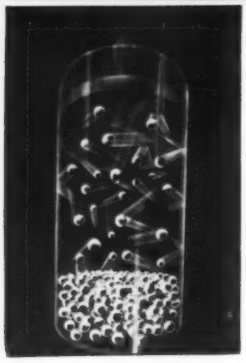
These solutions are practical:

(1) Provide all motor contactors with undervoltage relays to prevent automatic reclosing until the residual voltage at the motor terminals has decayed to 25% of normal value. This also necessitates having a potential transformer connected to the motor side instead of the line side of each contactor. This provides individual motor protection but is expensive to apply if required for many motors.

(2) Provide all motor contactors with an additional timing device to prevent reclosing until the motor residual voltage has had time to decay to below 25% value. For example, this timer might prevent reclosing after any outage for 2 seconds whereas the other timer for automatic reclosing would be set for 6 seconds. Then, if voltage recovers after an outage, motor contactors would pickup only during the interval between 2 and 6 seconds.. This requires additional expense in timing devices and in properly setting these devices. It causes longer outage time with consequent greater slip and higher reaccelerating currents for motors. But it also provides for diversity in reclosing time settings which helps to offset abnormal voltage regulation in transformers due to motor reaccelerating currents.

(3) Provide at a substation bus (to which several motors are connected through contactors or breakers) an undervoltage relay to prevent any main-breaker or tie-breaker closing from reapplying power to this bus until the residual voltage from motors has decayed to 25%. This type of protection is effective when all motors are connected to a bus through circuit breakers that do not open when voltage collapses. The larger or higher-speed motors with slower residual-voltage decay rates can then feed into the smaller or slower-speed motors so that the time for voltage decay to 25% on the bus will be shortened. However, if some motors have contactors which are supplied through a backup bus circuit breaker, an undervoltage relay on the

(*Continued on page* 182)



Throwing away mechanical shaft work as heat to "pack" gas molecules seems a strange way to transmit energy. This paradox makes it possible to use compressed air in an effective refrigerating system. It all depends on knowing . . .

How a compressed-air system really works

By B G A SKROTZKI, Associate Editor

How to figure compressed-air system performance (Figure 1):

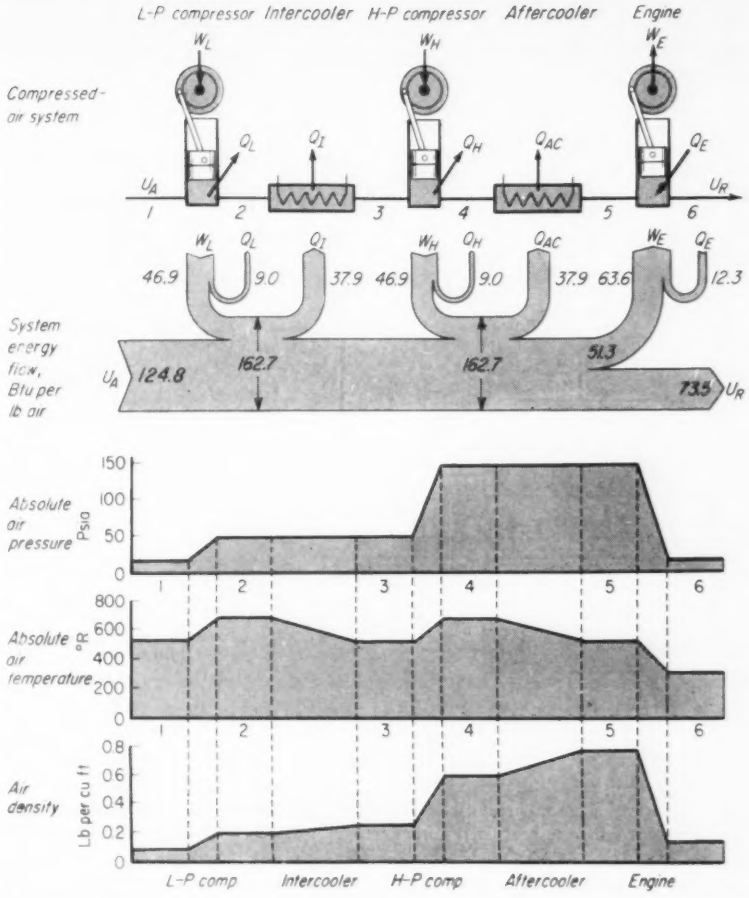
1. Polytropic compression and expansion: $n = 1.3$
2. Air specific heats: $c_p = 0.24$; $c_v = 0.1715$
3. Polytropic specific heat: $c_n = c_v\left(\frac{k-n}{1-n}\right)$
   $= 0.1715\left(\frac{1.4-1.3}{1-1.3}\right) = -0.0572$ Btu/lb/F
4. $P_2 = P_3$ chosen for minimum compressor work so:
5. $W_L = W_H$
6. $P_1 = P_6 = 14.7$ psia; $14.7 \times 144 = 2116$ psfa
7. $P_4 = P_5 = 147$ psia: $147 \times 144 = 21{,}160$ psfa
8. $P_2 = P_3 = \sqrt{P_1P_4} = \sqrt{2116 \times 21{,}160} = 6695$ psfa
9. $T_1 = T_2 = T_6 = 60 + 460 = 520$ °R
10. $V_1 = \frac{RT_1}{P_1} = \frac{53.3 \times 520}{2116} = 13.10$ cu ft/lb air
11. $D_1 = 1/V_1 = 1/13.10 = 0.07635$ lb/cu ft air
12. $U_A = c_pT_1 = 0.24 \times 520 = 124.8$ Btu/lb air
13. $P_2/P_1 = 6695/2116 = 3.165$
14. $P_4/P_3 = 21{,}160/6695 = 3.165$
15. $W_L = \frac{nP_1V_1}{1-n}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$
    $= \frac{1.3 \times 2116 \times 13.10}{1-1.3}(3.163^{\frac{1.3-1}{1.3}} - 1)$
    $= -36{,}540$ ft-lb/lb air
    $W_L = -36{,}540/778 = -46.9$ Btu per lb air
16. $\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} = \left(\frac{6695}{2116}\right)^{\frac{1.3-1}{1.3}} = 1.3043$
17. $T_2 = 1.3043\ T_1 = 1.304 \times 520 = 677.8$ °R
18. $V_2 = \frac{RT_2}{P_2} = \frac{53.3 \times 677.8}{6695} = 5.395$ cu ft/lb
19. $D_2 = 1/V_2 = 1/5.395 = 0.1854$ lb/cu ft
20. $S_2-S_1 = c_n\log_e(T_2/T_1) = -0.0572 \times \log_e 1.3043$
    $= -0.0152$
21. $Q_L = c_n(T_2-T_1) = -0.0572(677.8-520) = -9.0$ Btu/lb
22. $Q_I = c_p(T_3-T_2) = 0.24(520-677.8) = -37.9$ Btu/lb
23. $S_3-S_2 = c_p\log_e(T_3/T_2) = 0.24\log_e(520/677.8)$
    $= 0.24(-0.2655) = -0.0637$
24. $V_3 = \frac{RT_3}{P_3} = \frac{53.3 \times 520}{6695} = 4.14$ cu ft/lb air
25. $D_3 = 1/V_3 = 1/4.14 = 0.2415$ lb/cu ft air
26. $W_H = W_L = -46.9$ Btu/lb air
27. $\frac{T_4}{T_3} = \left(\frac{P_4}{P_3}\right)^{\frac{n-1}{n}} = 3.165^{0.2308} = 1.3043$
28. $T_4 = 1.3043\ T_3 = 1.3043 \times 520 = 677.8$ °R $= T_5$
29. $S_4-S_3 = c_n\log_e\frac{T_4}{T_3} = -0.0572\log_e 1.3043$
    $= -0.0152$
30. $Q_H = c_n(T_4-T_3) = -0.0572(677.8-520)$
    $= -9.0$ Btu/lb air
31. $Q_{AC} = c_p(T_5-T_4) = 0.24(520-677.8) = -37.87$ Btu/lb
32. $V_4 = \frac{RT_4}{P_4} = \frac{53.3 \times 677.8}{21{,}160} = 1.707$ cu ft/lb air
33. $D_4 = 1/V_4 = 1/1.707 = 0.586$ lb/cu ft air
34. $V_5 = \frac{RT_5}{P_5} = \frac{53.3 \times 520}{21{,}160} = 1.310$ cu ft/lb air
35. $D_5 = 1/V_5 = 1/1.310 = 0.7635$ lb/cu ft air
36. $W_E = \frac{nP_5V_5}{1-n}\left[\left(\frac{P_6}{P_5}\right)^{\frac{n-1}{n}} - 1\right]$
    $= \frac{1.3 \times 21{,}160 \times 1.31}{1-1.3}\left[\left(\frac{2116}{21{,}160}\right)^{0.2308} - 1\right]$
    $= 49{,}500$ ft-lb/lb air
    $W_E = 49{,}500/778 = 63.6$ Btu/lb air
37. $S_5-S_4 = c_p\log_e(T_5/T_4) = 0.24\log_e(520/677.8)$
    $= -0.0637$
38. $\frac{T_6}{T_5} = \left(\frac{P_6}{P_5}\right)^{\frac{n-1}{n}} = \left(\frac{2116}{21{,}160}\right)^{0.2308} = 0.5878$
39. $T_6 = 0.5878\ T_5 = 0.5878 \times 520 = 305.3$ °R
40. $Q_E = c_n(T_6-T_5) = -0.0572(305.3-520)$
    $= 12.28$ Btu/lb air
41. $U_R = c_pT_6 = 0.24 \times 305.3 = 73.3$ Btu/lb air
42. $V_6 = \frac{RT_6}{P_6} = \frac{53.3 \times 305.3}{2116} = 7.695$ cu ft/lb air
43. $D_6 = 1/V_6 = 1/7.695 = 0.130$ lb/cu ft air
44. $S_6-S_5 = c_n\log_e(T_6/T_5) = -0.0572\log_e\frac{305.3}{520}$
    $= 0.03037$

We have examined in detail the behavior of components of a compressed-air system, but haven't taken the time to put any quantities in our performance formulas. We can't understand formula fully until we see how the quantities behave for given conditions. Let's do this now by working out an example for the system shown in Fig. 1.

We have here a 2-stage air compressor, intercooler, aftercooler, and a single-stage engine. The air compressor takes in free air at 14.7 psia and 60 F. The coolers reduce temperature of the compressed air back to 60 F after each stage. The engine exhausts the spent air back to atmosphere at 14.7 psia.

Both compressors and engine work on reversible polytropic processes with $n = 1.3$. To simplify calculation we assume both compressors and engine have zero clearance.

Now dust off your slide rule, get out your file of *Thermo Refreshers*, and follow through the calculations in the table on p. 94. You'll find all the formulas explained in the past *Refreshers*. We figure here the state of the air entering and leaving each component of Fig. 1, and the energy entering and leaving each component and the total system. If you really want to understand compressed-air thermo, don't skip studying and checking this table step by step.

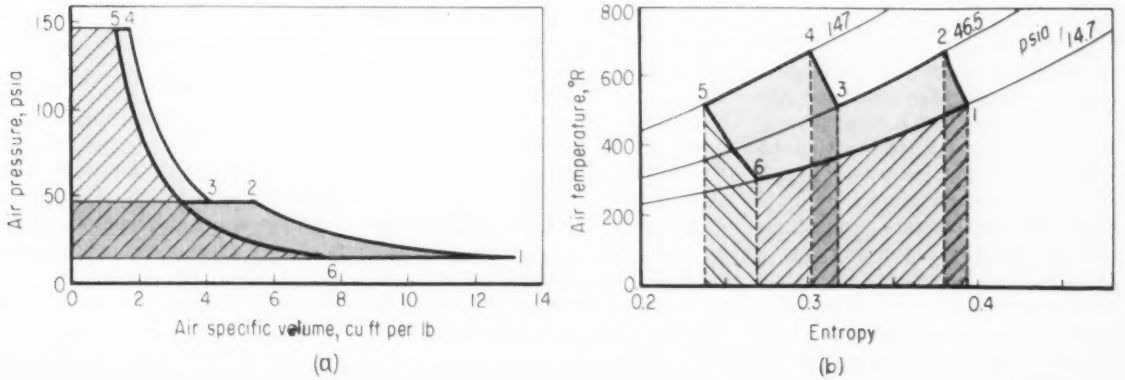


1 Two-stage air compressor with inter- and after-cooling feeding singlestage air engine taps free air's internal energy to produce work output at the air-engine shaft

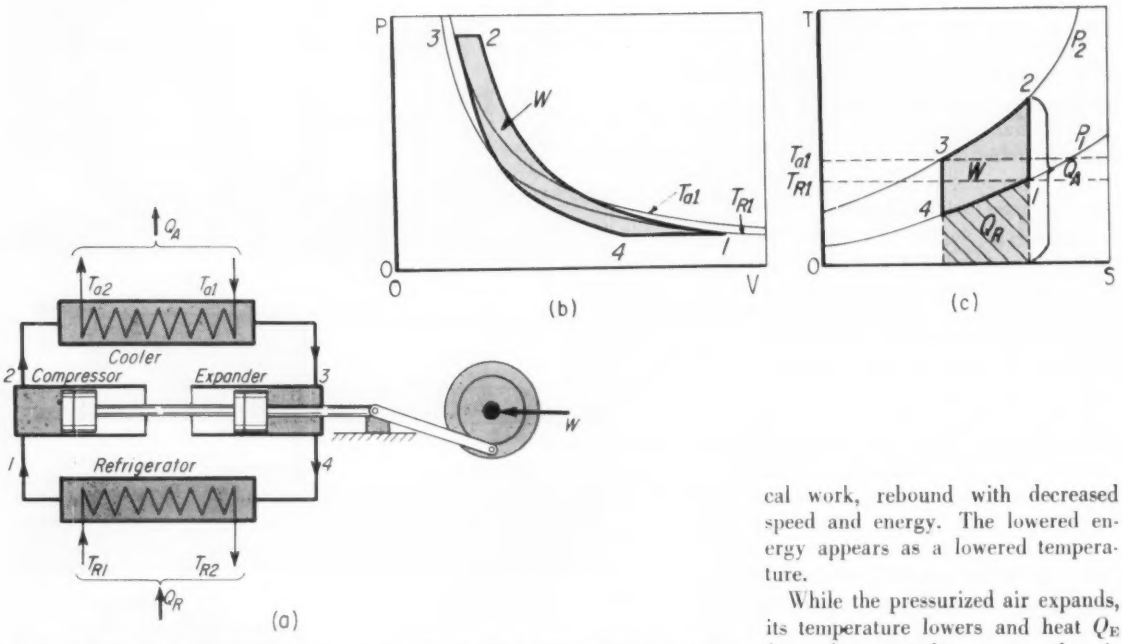
Energy flow through a system like Fig. 1 usually holds some surprises for the novice. We give an *energy-flow* diagram below the system diagram in Fig. 1. These energies are all calculated in the table, and determine widths of the diagram.

The L-P compressor has two energy inflows, shaft work W_L, and the energy carried by the entering air, U_A. Because the compression is polytropic the compressing air rejects heat Q_L, usually to the cylinder jacket-cooling water. The rest of the incoming energy leaves as increased energy of the compressed air.

We don't know the true energy carried by the incoming air U_A,



2 P-V and T-S graphs show state variations of air for system in Fig. 1; net areas *1-2-3-4-5-6* measure net shaft work lost. Compressor and engine use polytropic process with $n = 1.3$; no pressure loss is assumed in connecting piping or in air coolers



3 Closed system makes it possible to use cold air exhausted from expander (air engine) for removing heat energy from refrigerated areas. *W* activates cooling system

but we can figure a pseudo-energy by assuming the specific heat $c_p = 0.24$ Btu per lb, F of air holds constant all the way from absolute zero temperature. The flow diagram, Fig. 1, then shows that 124.8 Btu per lb air enters the system. Of 46.9 Btu per lb input by W_L, 9.0 Btu immediately leaves as heat through the cylinder walls and 37.9 Btu enters the air. The air leaves the l-p cylinder with 162.7 Btu per lb.

The intercooler removes the heat put in by the l-p compressor as heat Q_I, and cools the air back to atmospheric temperature. The partly compressed air leaves the intercooler with no more energy than it originally had as free air. Not a seemingly profitable arrangement, energywise.

The three lower graphs of Fig. 1 show how the pressure, temperature and density of the air vary as it flows through the system. These show that at state *3* all we have gained is increased pressure and density. Since the air temperature is the same as atmospheric, the air molecules at *3* move with the same average speed, hence have no increased energy. But since the density has been raised, this means a given number of molecules have been packed into a smaller space. This causes them to hit the container walls more frequently and so raise the pressure.

We could say from state *1* to *3* we have gone through a "packing" operation and thrown away the valuable available shaft energy we used to do this.

In the h-p compressor and aftercooler we do exactly the same thing as in the l-p compressor, to further increase air pressure. For an economic compressor $W_H = W_L$ as we learned in Part 15, Jan 1958. So at state *5* we have the molecules more tightly packed, but have thrown away W_L and W_H as heats Q_L, Q_I, Q_H, and Q_{AC}.

With no net gain in energy in our h-p air we seem to have a useless product on our hands. But let's not forget that pressurized air can exert a force—and a moving force can do mechanical work.

When we admit h-p air, *5*, into the engine cylinder, the molecules slam into the moving piston, do mechanical work, rebound with decreased speed and energy. The lowered energy appears as a lowered temperature.

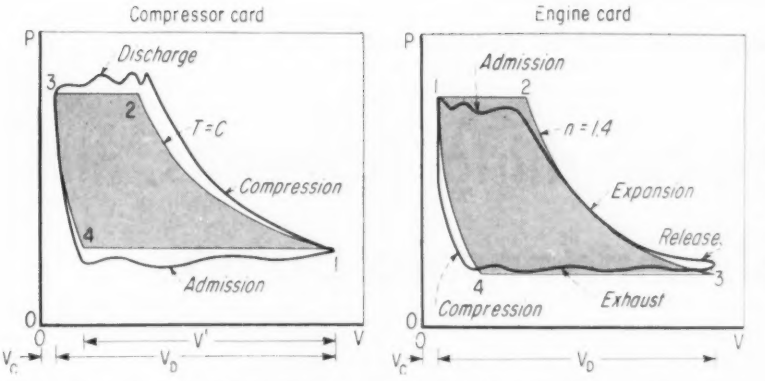
While the pressurized air expands, its temperature lowers and heat Q_E from the atmosphere enters the air through the cylinder walls to help produce engine shaft output W_E.

Energy flow diagram, Fig. 1, shows that 51.3 Btu per lb air joined by 12.3 Btu from atmosphere produces 63.6 Btu per lb air engine output. Air exhausted by the engine at state *6* leaves with only 73.5 Btu per lb. It entered the system with 124.8 Btu per lb. As the temperature diagram shows the air becomes very cold. While its pressure is atmospheric the density is higher than free air because of the greater number of slower moving molecules.

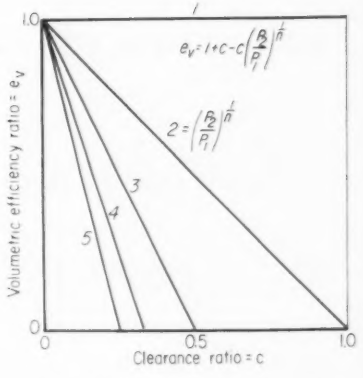
(NOTE: Fig. 1 energy flow has been balanced to show 73.5 Btu per lb air leaving, while the table indicates 73.3 Btu. The difference is caused by rounding of figures and slide-rule reading errors.)

Fig. 2 gives the P-V and T-S diagrams for the system of Fig. 1. In *a*, gray area to left of process *1-2* measures the l-p compressor work input W_L. Gray area to left of *3-4* shows h-p compressor work input W_H. Then, total gray areas measure total shaft work input to the system. Hatched area to left of *5-6* shows work output of the engine, W_E. Since engine and compressor work areas coincide, the net area *1-2-3-4-5-6* shows mechanical work lost by the system.

In Fig. 2*b*, gray area under *1-2*



4 Actual compressor uses more work input than ideal compressor working between same limits, while actual air engine produces less work than an ideal air engine



5 Conventional volumetric efficiency ratio depends on several design factors

shows heat rejected by l-p compressor, Q_L. Gray area under *2-3* shows heat rejected by intercooler Q_I. Gray area under *3-4* shows heat rejected by h-p cylinder, Q_H. Gray area under *4-5* gives heat rejected by aftercooler, Q_{AC}.

Hatched area under *5-6* indicates heat absorbed in engine cylinder, Q_E. Hatched area under *6-1* measures the amount of heat needed to reheat the exhaust air at *6* back to atmospheric temperature at *1*, from U_R to U_A. Net area *1-2-3-4-5-6* shows net amount of heat rejected by the pressurized air to the atmosphere.

How are net areas of Fig. 2 related? For this we must go to the circuit diagram of Fig. 1 and make a first-law analysis. For steady air flow through the system, no energy accumulates in or drains from the system. So all energy entering system must equal energy leaving:

$$U_A + W_L + W_H + Q_E = Q_L + Q_I + Q_H + Q_{AC} + W_E + U_R$$

Rearranging terms we get:

$$W_L + W_H - W_E = Q_L + Q_I + Q_H + Q_{AC} - Q_E - (U_A - U_R)$$

Left side of equation is net mechanical work lost by system, right side is the net heat lost by system to atmosphere. This means both net areas are equal in Fig. 2 and represent net work lost.

Remarkable thing about this system is that the total shaft work we put in is thrown away as heat to the atmosphere. Shaft work we get out as the final product comes from part of internal energy of the compressed air, which is the same as the internal energy of the free air. This makes the exhaust air very cold.

Refrigeration. Since we can get cold air from the system of Fig. 1, this suggests a scheme for a refrigerating system. In Part 11, August 1957, pp 92-93, we talked about the principles of a refrigerating system. Fig. 3*a* shows the closed compressed air-system that can be used to remove energy from a low temperature region or refrigerator.

Air at atmospheric pressure and state *1* enters the compressor. The compressor pressurizes the air and raises its internal energy and temperature to state *2*. Pressurized hot air then enters the cooler which removes some of the air's internal energy as Q_A, cooling the air to atmospheric temperature T_{a1}. Cooling water usually does this job. Cooled pressurized air at state *3* then enters the air engine or *expander* and contributes shaft work to drive the compressor. The air expands at constant-*S* so its pressure drops to atmospheric but its temperature much lower than atmospheric, to T_4.

The cold air at state *4* then enters the refrigerator and picks up heat Q_R from the medium being cooled. The air leaves at state *1* to re-enter the compressor and repeat the cycle.

Fig. 3*b* and *c* show the state changes on P-V and T-S graphs. The net area *1-2-3-4* measures the difference between compressor work input and the work developed by the expander. This work difference W (equivalent to that lost by a conventional compressed-air system) must be supplied from the outside to make the refrigerating system work.

In Fig. 3*c* the total gray area under *2-3* measures the heat rejected to atmosphere by the cooler, the hatched area under *4-1* measures the heat removed in the refrigerator. Net area *1-2-3-4* measures work input to the system. By first-law analysis of Fig. 3*a* we see that energies entering and leaving must balance as $W + Q_R = Q_A$ or $W = Q_A - Q_R$.

Actual performance of compressors and engines differ in degree from the ideal reversible processes we have been studying. The ideal performances are easy to calculate, and set up the maximum possible goal. We then compare actual performance against the calculated ideals.

Fig. 4*a* compares an actual P-V graph for a compressor against a reversible ideal using constant-*T* compression. At state *1* actual pressure is slightly lower than atmospheric. Compression actually follows a path between constant-*T* and constant-*S*, this makes the gas reach discharge pressure sooner than the constant-*T* process. Cylinder pressure surges above the discharge pressure because a slightly higher pressure is needed to automatically open the discharge valve.

The varying rate of piston motion and the pressure difference between cylinder air and air in the discharge line sets up pressure waves during

(*Continued on page* 192)

Condensate handling: hotwells, air removal, condensate pumps

Last month we discussed the condenser circulating-water system. Now, let's turn to the equipment and procedures for handling the condensate itself

By DONALD SWIFT, Ebasco Services Incorporated

Before we go into the problems of condenser testing and operation (in the next article of this series) let's consider some of the important aspects of condensate handling.

Hotwells. The condenser hotwell provides a place for accumulating the condensed steam dripping off the condenser tubes. It is usually, but not always, directly below the condenser proper. In deaerating units, the incoming condensate runs across saw-tooth weirs or many-holed plates that break it into fairly small droplets. Some of the incoming steam sweeps by the falling water particles, heating them and carrying off the released gas.

At installation and later during operation and maintenance, it is essential that weirs or other water-distributing means are level or arranged so the water is evenly distributed. Then steam can obtain as intimate a contact as possible.

Hotwells usually hold five or ten minutes' condensate accumulation at full load. They normally have gage glasses and high and low-level alarms. A float-operated or pilot-controlled valve in the hotwell pump-discharge line keeps water level at the desired point.

Normal water level is well up in the hotwell to provide a condensate reserve. If carried too high, however, it restricts the space available for condensate buildup in case of pump failure. If water gets high enough to seal the air-pump off-take, condenser vacuum is lost. Low water usually does no serious harm, although if the pump suction head becomes too low, cavitation may occur.

With some older condensate-pump styles, water level adjusted itself. As the level fell and cavitation occurred, pump output was reduced until it just balanced the rate at which condensate was being removed. The cavitation often produced an unpleasant rattle in the pump at light load, and sometimes caused pump impeller surfaces to pit.

Steam from the turbine enters the condenser at high speed, particularly when vacuum and load are high. Condenser tubes are usually arranged in groups with open lanes between them so steam penetrates rapidly toward the hotwell with little or no pressure loss. The lanes may become narrower near the bottom of the condenser since a smaller passage area is needed as condensation reduces the steam volume. This laning of the tube bank represents one of the major improvements over early-day condensers.

A smaller number of tubes produces better vacuum and reduced condensate refrigeration. If steam has good access to the hotwell, condensate outlet temperature may be even higher than the temperature corresponding to the vacuum. This is possible because the vacuum as usually measured in the condenser inlet conduit does not take the high-velocity head into account. If this velocity is not dissipated before steam enters the hotwell, it may cause a higher absolute pressure, and therefore a correspondingly higher condensate temperature at that point.

Air removal. The condenser must have a means for continuously removing noncondensable gases that enter with the steam. This prevents the condensing surface from becoming blanketed with gas and insures that total gaseous pressure in condenser is caused as much as possible by water-vapor pressure alone. A bank of tubes carrying the coolest possible condensing water is placed in front of each air outlet to condense maximum amount of water vapor. Thus air-

removal pumps can handle a greater quantity of air.

One design uses separate shells for air-cooler tube banks so greater water flow in these tubes can produce better heat transfer. Most air off-takes are near bottom or on the side of condenser tube bank so air is removed and steam flows into tube bank without interfering with condensate flow. If steam enters from side, other arrangements may be used to keep air accumulations at a minimum.

Air and other noncondensables are removed by pumps that maintain a vacuum slightly greater than that in the condenser. The two basic pump types are positive displacement and jet. Positive-displacement units may use a reciprocating piston or a rotating impeller with movable vanes set in an eccentric casing. Another type of reciprocating unit has suction and discharge valves, operating much as any other air compressor. These pumps need a large piston displacement, particularly when operating under high vacuum.

The jet pump most frequently used for air removal employs steam as the operating medium. A large-capacity nozzle exhausting to atmosphere generally exhausts air when condenser first starts and handles large-volume air leakage until low-pressure water-sealed glands seal completely. This nozzle, often known as a "hogging jet," cannot produce a very high vacuum; is generally limited to a maximum of 26 to 28 in. Hg. Supply steam pressure may be critical in determining optimum jet performance. Pressures higher than design values may handle more air but will not produce as high a vacuum.

A two- or three-stage jet pump of smaller capacity removes air continuously at high vacuum while turbine is in normal operation. The first stage takes a large volume of air-water vapor mixture and compresses it to perhaps 20 in. Hg vacuum. The mixture of air, water vapor and jet steam is then passed over a bank of water-cooled tubes to condense water vapor and steam down to a pressure roughly corresponding to watertube temperature. Thus the following jets handle a smaller vapor quantity. The second-stage jet then picks up remaining uncondensed gases and compresses them further—either to atmospheric pressure, or, if a three-stage jet is used, to final-stage suction pressure.

Interstage condensation not only reduces the quantity of water vapor handled by the following jets, but also permits saving condensed steam for return to the main condensate system. Heat in the condensed steam and water vapor may be saved by using condensate that is on its way to the boiler as a cooling medium in the condenser tubes. In some cases, saving condensed steam may not be desirable because of a high ammonia content.

Often there are two jets in parallel for each stage, giving extra capacity for high leakage and providing a reserve jet to allow for normal operation of the unit if one jet happens to become plugged or is inoperative for some other reason.

Vacuum traps or seal loops in the line draining the condensate back to the condenser may be used to reclaim water condensed in steam-jet air-pump inter- or after-cooler. Since the vacuum in the first-stage cooler, usually called the intercooler, is only six or eight inches less than in the condenser, a loop seal is simpler and more satisfactory than a trap. If the seal is lost or a trap sticks open, compressed air in the intercooler recirculates back to the condenser. Then jets are overloaded and condenser vacuum is adversely affected.

It is advisable to (1) have an amply deep loop seal (2) have the intercondenser leg of the loop several times larger in diameter than the condenser leg so there will be a reserve supply of water in the loop in case of pressure surges that might otherwise blow the water out of the seal (3) provide a water supply for refilling the seal loop if water is lost (4) provide a gage glass on the loop so water level can be checked. Drainage traps are usually installed in parallel, with isolating valves at inlet and outlet of each so one trap can be serviced while the other is in use.

Reducing valves may provide steam to the jets at design pressure, since pressures materially above or below the optimum affect jet performance adversely. Orifices may reduce steam pressure—usually to not more than 400 psig. Usually, each jet on the steam supply, jet suction and jet discharge has an individual shutoff valve. A relief valve on the jet discharge warns and protects against overpressure in case steam is turned on with the discharge closed. Discharge valves may be omitted on last-stage jets that discharge to the atmosphere.

If cooling water for inter- and after-condensers of steam-jet air pumps is not cool or plentiful enough, steam and water vapor from jets is not sufficiently condensed and reduced in volume; then jets that follow are overloaded; consequently the condenser vacuum suffers.

Where condensate from the main condenser is used for cooling, jets may be overloaded when unit is coming up to speed or operating at low load. A line for recirculating condensate back to the condenser is, therefore, used to increase flow through the steam-jet air-pump condensers. Recirculated water sprays over a portion of the main condenser tubes so it is cooled as much as possible. This recirculation may be controlled automatically by using temperature rise of the condensate passing through the steam-jet air pump as a guide and actuating medium. Gas or liquid-filled bulbs at inlet and outlet of the steam-jet air pump open a control valve in the recirculating line when temperature difference exceeds 8 or 10 F. As load increases and condensate flow becomes great enough to reduce the rise, the recirculation control valve closes.

The recirculating line should take off just after the steam-jet air pump and *(Continued on page 194)*

Power to grow ...electrically

NO. 13: CHANGING VOLTAGE

BYERS AND T B KNEEN, *l to r*, planning the ground rules for changeover

With six 2-man crews working to a well-planned schedule, H E Byers* carries out . . .

A 20-year PTG payoff: Penn State U

Back in 1955 a hard look at this university's growth curve showed clearly that electrical load would creep beyond distribution-system capacity within two or three years. By way of solution, two paths could have been taken: (1) install more ducts and cables or (2) raise distribution voltage. But reinforcing the duct system would mean ripping up the campus. And duct size ruled out pulling in heavier cables. That's why the higher-voltage alternate was chosen as most practical. One reason for its being most practical was the advance planning started back in 1938 when first generator was installed.

Like many plants and all universities, Penn State is suffering from growing pains. It's been Department of Physical Plant's job to meet this demand for greater utility services. High- and low-pressure steam, electricity, compressed air and other power services are supplied from the power plant built in 1929 on the southwest corner of the campus. It now has an installed capacity of 200,000 lb of steam per hr using coal-burning equipment plus two oil-fired boilers rated 20,000 lb per hr each. Oil-fired units are low pressure for emergency and standby service.

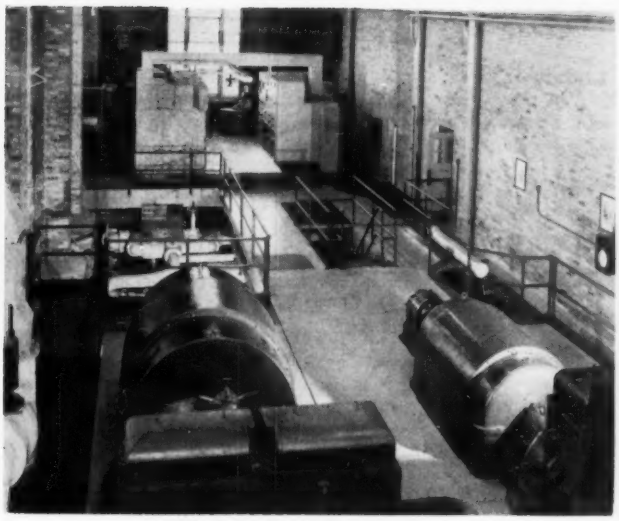
Electrical supply comes from two turbine-generators and the West Penn Power Co. The in-plant generators are rated 5000 and 3000 kva. Larger of the two units is a condensing machine with extraction at 12 lb while the 3000-kva unit is noncondensing. In addition to distribution facilities, one big problem has been to "beef up" the electrical supply capacity in light of a 10% annual load growth. Present peak load is beyond 6000 kw. Since power plant is operated mainly for heat and process, electrical generation is essentially a byproduct. And because turbine load is determined by steam demand, a tie with West Penn is available on a power-interchange agreement. Up to 5500 kw can be had from this source. Right now over 80% of the university's electrical needs are met by in-plant generation.

In 1938, when smaller of present two generators was installed, first PTG step was taken by specifying a dual voltage unit that could readily be changed over through external connections. Same planning held for 5000-kva unit in 1949. Then in 1954, when original switchgear was replaced with modern metalclad gear, plans were laid for later dovetailing it into the higher voltage system. Selection of meters, relays, instrument transformers for the 14-cubicle 2-section equipment was such that later swing to a higher voltage could be done with minimum downtime and expense.

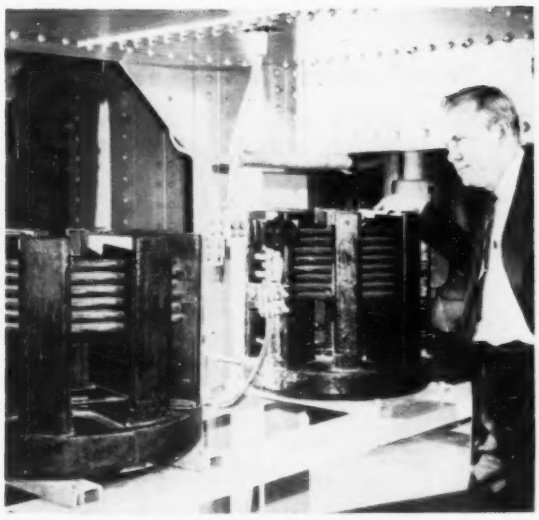
Distribution from the power plant is over six underground feeders serving one overhead line and 34 transformer vaults plus other load points. All main cables leaving the plant are 350-mcm 3-conductor varnished-cambric lead-covered. Cables are connected through disconnecting-type potheads to simplify load distribution flexibility and provide isolation in case of trouble.

All main feeders have been installed since 1945 and are designed for 5000-v service. Many of the smaller cables have been in service for 30 years and are standing up well under the higher operating volt-

*H E Byers is assistant head of Division of Utilities at Pennsylvania State University, University Park, Pa.



PLANT GENERATORS reconnected delta-wye for 4.16 kv



REACTORS in generator neutrals check s-c currents

ups 2.4 kv to 4.16 for distribution

New reactors limit fault currents to safe value

The newly installed neutral wire connects to both in-plant generators through current-limiting reactors. This addition holds s-c currents to a safe value well within breaker ratings. Calculations indicated a reactor with 0.09 ohms reactance was needed for the 5000-kva generator and a unit with 0.089 ohms reactance was best suited to the smaller machine.

It was possible to mount reactors directly under one of the generators while running the common ground wire to switchgear bus. A 4/0 bare wire extends from the switchgear to the West Penn transformer vault.

An air-core reactor, because of the concentrated magnetic field surrounding the conductors, has cables made up of small wire strands to hold eddy currents to a minimum. In parallel windings it is necessary that reactance and resistance of the parallel paths be the same to avoid circulating currents. This is insured by carefully checking conductor lengths.

age. For the last few years only 4 in. or larger ducts were used; prior to that they were 3 in. or smaller.

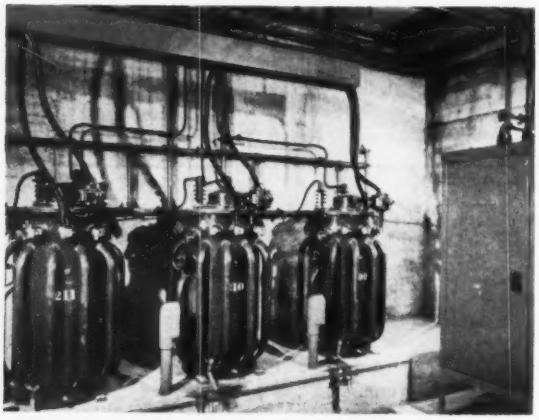
In January 1956 decision was reached on the voltage changeover and the schedule laid out calling for actual voltage change to occur during June and July 1957. Planning consisted of determining actually what was necessary in the power plant, on distribution lines, transformer vaults, laboratories, etc. Needed material was listed and ordered. Then the detailed work schedule was laid out on a month-by-month basis. Many proposed power interruptions had to be scheduled months in advance because of lab experimental work.

Preliminary work included installation of a neutral wire in the duct system and overhead lines to handle the new 3-phase 4-wire 4.16-kv distribution, new metering equipment, rewiring of transformer rooms, relocation of many transformers to better utilize their capacity, installation of new high-tension entrance switches in vaults and new auto-transformers in some locations.

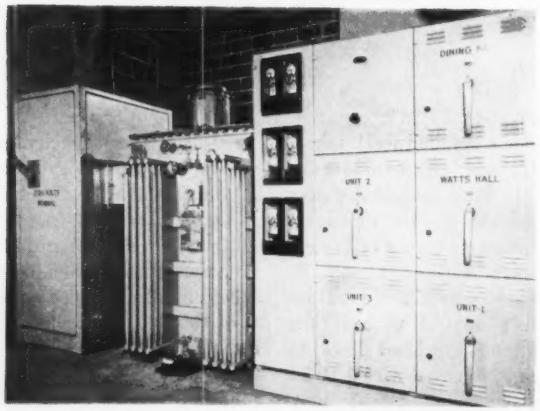
Neutral wire was grounded wherever possible, also bonded to the lead sheath in all manholes. About 20,000 ft of this No. 1/0 conductor was installed in the underground ducts and some 30,000 ft of bare wire went in four feet below the crossarm on pole lines. This wire was grounded at least every 1200 ft, connected to each

Transformers play top role in voltage change

NEW COILS were used here to match higher voltage, rather than reconnecting old ones. Transformer shown is 750-kva delta unit



CURRENT TRANSFORMERS, slipped over transformer's secondary leads, permit metering with a 2½-amp 2½-element 3-ph unit



NEW TRANSFORMERS were fitted into unit substation fashion, alongside relays, air breakers, high-voltage interrupter lightning-arrestor ground and guy wires. In all cases where there was a wye-wye hookup, secondary and primary neutrals were tied together.

Since metering needs were heavy, standardizing on a meter that could be used for practically all services became a necessity. A 2½-amp 2½-element 3-phase 4-wire socket-type unit with secondary reading and 15-minute demand register was selected. In combination with 200- to 800- amp current transformers, this instrument could meter all loads.

Most transformer banks were made up of three single-phase units so there was no problem in reconnecting delta to wye. In one area several 2.4-kv motors, switches, transformers, mg sets and some test equipment were fed through stepdown transformers from the 4.16-kv system because reconnecting individual equipment was impractical. A 300-kw 4160-v delta primary, 2.4-kv delta secondary handled this load. This delta-primary hookup should help reduce third harmonics in the system. In another area, an arc furnace couldn't be reconnected so an autotransformer was installed.

In February 1957, through press, radio, campus publications and other announcements, dates of actual changeover and a schedule of interruptions were publicized. Changeover was started on June 12, completed July 1. Power-plant electrical scheme was well suited for changeover because of an auxiliary transfer bus between main bus and outgoing cables. This could be energized from West Penn Power without going through main bus structure. It was a simple matter of carrying all plant load on the main bus, then energizing the transfer at the higher voltage from West Penn. As each cable was set up for 4.16 kv, it was fed from transfer bus and the load handled by the utility company. This was done until all load was on the transfer bus. Then plant generators and switchgear were changed to the higher voltage. Once this work was completed the two systems were synchronized and load picked up on the main bus.

Total job was handled by six 2-man crews. Average interruption during changeover was 30 minutes.

Power's data sheet

Seamless carbon-steel pipe to ASTM Spec -53 Grade A and Spec A-106 Grade A

Pipe Size In.	Nom. OD In.	Wall Thick In.	Temperature — F: To 650	700	750	775
			Maximum Allowable Stress — PSI: 12,000	11,650	10,700	9,850
Schedule 10						
14	14	.250	264	256	235	219
16	16	.250	228	221	203	191
18	18	.250	204	198	182	169
20	20	.250	186	181	166	153
24	24	.250	156	151	139	128
Schedule 20						
8	8.625	.250	432	419	385	357
10	10.75	.250	348	338	310	286
12	12.75	.250	288	280	257	240
14	14	.312	360	350	321	296
16	16	.312	312	303	278	259
18	18	.312	276	268	246	230
20	20	.375	324	314	289	262
24	24	.375	264	256	235	218
Schedule 30						
8	8.625	.277	504	489	449	411
10	10.75	.307	462	449	412	379
12	12.75	.330	432	419	385	351
14	14	.375	456	443	407	375
16	16	.375	396	384	353	328
18	18	.438	432	419	385	352
20	20	.500	456	443	407	373
24	24	.562	432	419	385	356
Schedule 40						
½	.84	.109	1356	1316	1209	1112
¾	1.05	.113	1164	1130	1038	952
1	1.315	.133	1260	1223	1123	1030
1¼	1.66	.14	852	827	760	695
1½	1.90	.145	804	780	717	660
2	2.375	.154	720	699	642	595
2½	2.875	.203	972	944	867	799
3	3.50	.216	876	850	781	718
4	4.50	.237	780	757	695	638
5	5.563	.258	708	687	631	584
6	6.625	.28	666	652	599	547
8	8.625	.322	612	594	546	506
10	10.75	.365	576	559	514	475
12	12.75	.406	552	536	492	456
14	14	.437	552	536	492	454
16	16	.50	570	548	503	468
18	18	.562	576	559	514	477
20	20	.593	552	536	492	455
24	24	.687	546	530	487	448
Schedule 60						
8	8.625	.406	828	804	738	681
10	10.75	.50	852	827	760	703
12	12.75	.562	828	804	738	678
14	14	.593	804	780	717	656
16	16	.656	780	757	695	643
18	18	.750	804	780	717	664
20	20	.812	792	769	706	652
24	24	.968	804	780	717	659
Schedule 80						
½	.84	.147	2424	2353	2161	1994
¾	1.05	.154	2076	2015	1851	1700
1	1.315	.179	2089	2028	1863	1715
1¼	1.66	.191	1548	1503	1380	1274
1½	1.90	.20	1452	1410	1295	1196
2	2.375	.218	1332	1293	1188	1091
2½	2.875	.276	1554	1509	1386	1276
3	3.50	.30	1416	1375	1263	1161
4	4.50	.337	1284	1246	1145	
5	5.563	.375	1176	1141	1049	968
6	6.625	.432	1176	1141	1049	967
8	8.625	.50	1075	1044	959	883
10	10.75	.593	1044	1013	931	861
12	12.75	.687	1044	1013	931	857
14	14	.75	1044	1013	931	861
16	16	.843	1044	1013	931	858
18	18	.937	1044	1013	931	855
20	20	1.031	1044	1013	931	853
24	24	1.218	1032	1002	920	850
Schedule 100						
8	8.625	.593	1320	1281	1177	1083
10	10.75	.718	1308	1270	1166	1077
12	12.75	.843	1320	1281	1177	1085
14	14	.937	1356	1316	1209	1110
16	16	1.031	1308	1270	1166	1076
18	18	1.156	1320	1281	1177	1082
20	20	1.281	1320	1281	1177	1086
24	24	1.531	1332	1293	1188	1093
XX						
½	.84	.294	7378	7162	6578	6056
¾	1.05	.308	6025	5849	5372	4946
1	1.315	.358	5712	5545	5093	4688
1¼	1.66	.382	4464	4334	3980	3664
1½	1.90	.400	4092	3973	3649	3359
2	2.375	.436	3588	3483	3199	2945
2½	2.875	.552	3948	3833	3520	3241
3	3.50	.600	3528	3425	3146	2896
4	4.50	.674	3084	2994	2750	2531
5	5.563	.750	2784	2703	2482	2285
6	6.625	.864	2736	2656	2440	2246
8	8.625	.875	2087	2026	1861	1713
Schedule 120						
4	4.50	.438	1788	1736	1594	1471
5	5.563	.50	1704	1654	1519	1396
6	6.625	.562	1632	1584	1455	1339
8	8.625	.718	1656	1608	1477	1356
10	10.75	.843	1584	1538	1412	1298
12	12.75	1.00	1608	1561	1434	1319
14	14	1.093	1608	1561	1434	1321
16	16	1.218	1584	1538	1412	1297
18	18	1.375	1596	1549	1423	1312
20	20	1.50	1572	1526	1402	1292
24	24	1.812	1602	1555	1423	1315
Schedule 140						
8	8.625	.812	1908	1852	1701	1567
10	10.75	1.00	1920	1865	1712	1580
12	12.75	1.125	1836	1782	1637	1507
14	14	1.25	1872	1817	1669	1539
16	16	1.438	1896	1841	1691	1560
18	18	1.562	1848	1794	1648	1513
20	20	1.75	1872	1817	1669	1534
24	24	2.062	1848	1794	1648	1515
Schedule 160						
½	.84	.187	3636	3530	3242	2988
¾	1.05	.218	3600	3495	3210	2957
1	1.315	.25	3432	3332	3060	2821
1¼	1.66	.25	2400	2330	2140	1974
1½	1.90	.281	2472	2400	2204	2032
2	2.375	.343	2580	2505	2301	2118
2½	2.875	.375	2369	2300	2112	1944
3	3.50	.438	2344	2275	2090	1924
4	4.50	.531	2292	2225	2044	1885
5	5.563	.625	2232	2167	1990	1834
6	6.625	.718	2184	2120	1947	1796
8	8.625	.906	2172	2109	1937	1783
10	10.75	1.125	2202	2138	1963	1807
12	12.75	1.312	2184	2120	1947	1796
14	14	1.406	2136	2074	1905	1756
16	16	1.593	2136	2074	1905	1752
18	18	1.781	2136	2074	1905	1750
20	20	1.968	2130	2068	1899	1748
24	24	2.343	2124	2062	1894	1744

NOTES:

Section 1 of Code for Pressure Piping limits use of A53 Seamless to 600 psi max.

Maximum Allowable Working Pressures are based on the following formula:

$$P = \frac{S}{\frac{1}{2}\left(\frac{D}{tm\text{-}c}\right) - y}$$

Maximum allowable working pressure — 1

Figures in body of table are pressures in psi for given temperatures and pipe sizes. These are based on *American Standard Code for Pressure Piping*, ASA B31.1—1955. Tables in this new series replace those starting with *Data Sheet 241*, July 1952, POWER. Revised Code allows higher working pressures, reduces top temperatures for carbon-steel pipe below original levels.

GEORGE C HALZEL, *Boston, Mass.*

© POWER

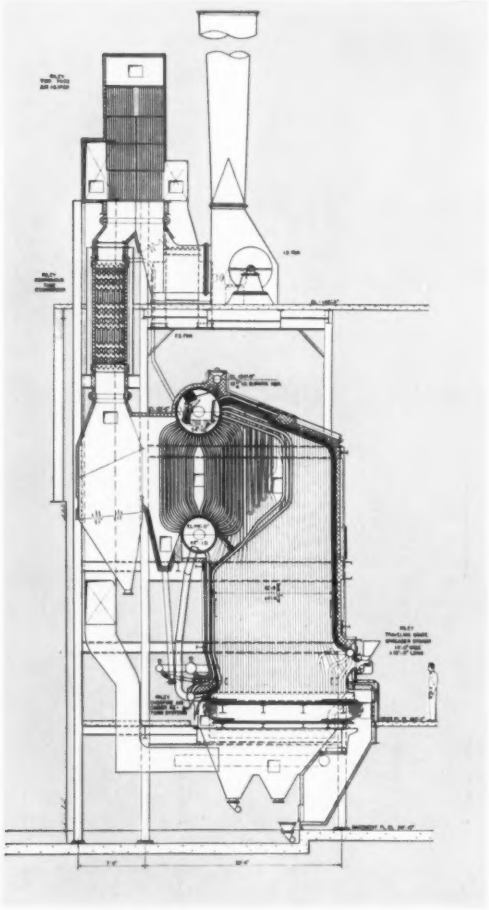
PRIZE WINNING RILEY BOILERS

These Riley Boilers played important roles in winning awards for outstanding modernization of steam generating facilities in contests recently conducted by POWER magazine. Each design was required to meet exacting specifications for size and arrangement in order to fit into restricted building space. Each has produced high fuel economies and high boiler efficiencies to earn at least a 20% annual return on the original investment.

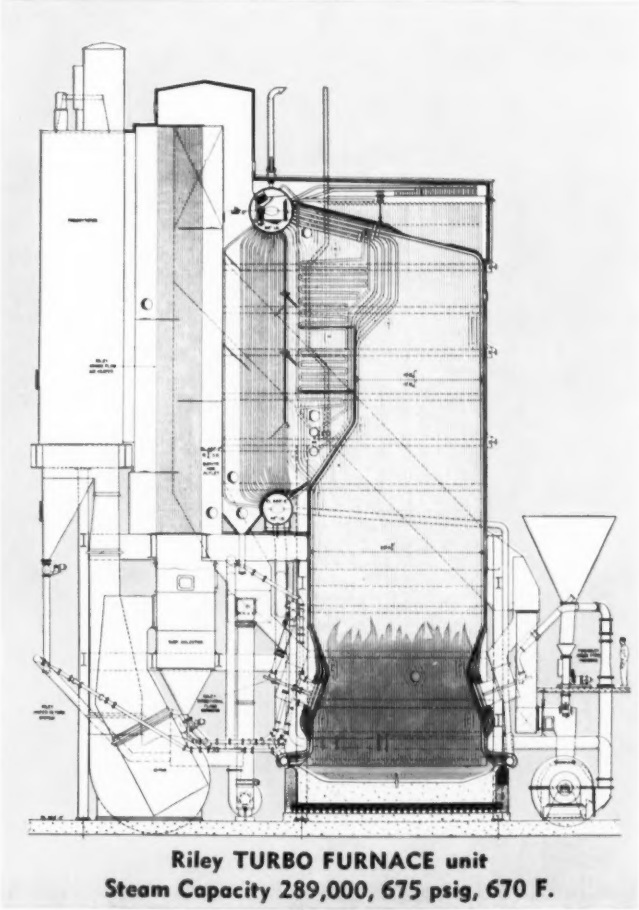
Hundreds of Riley industrial boiler installations are also paying similar bonus dividends in yearly net efficiency, dependability and in continuous, uninterrupted operation.

New additions to engineering facilities at Worcester and expanded production facilities at Riley's Pennsylvania plant will now speed delivery of Riley industrial type boilers from 50,000 lbs/hr and up. *Riley Stoker Corporation, Worcester, Mass.*

Representatives in Buffalo, Chicago, Cleveland, Detroit, New Orleans, New York, Philadelphia, Pittsburgh, Atlanta, Charlotte, Cincinnati, Houston, Kansas City, Los Angeles, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco and Seattle.

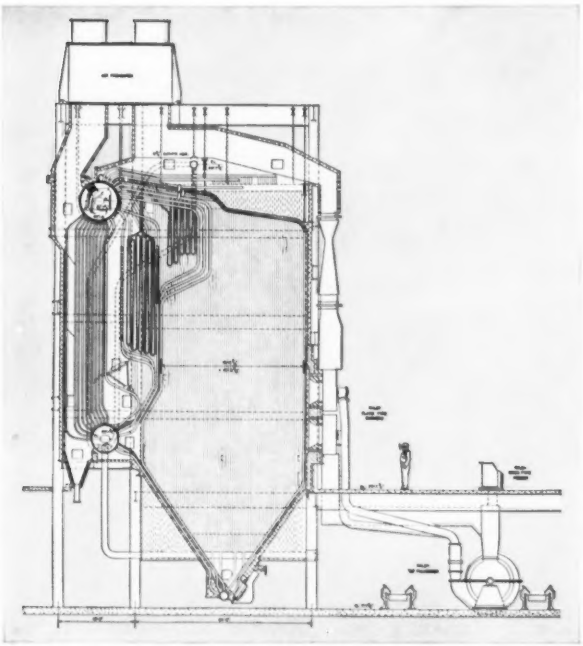


Garlock Packing Co., Palmyra, New York
100,000 lbs/hr Riley Single Pass Boiler Fired by Riley Traveling Grate Spreader Stoker. 425 psig., 600 F. Cinder Reinjection.

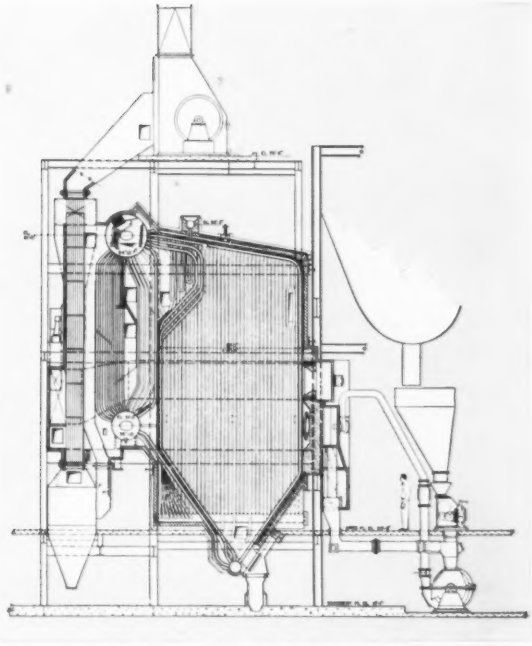


Riley TURBO FURNACE unit
Steam Capacity 289,000, 675 psig, 670 F.

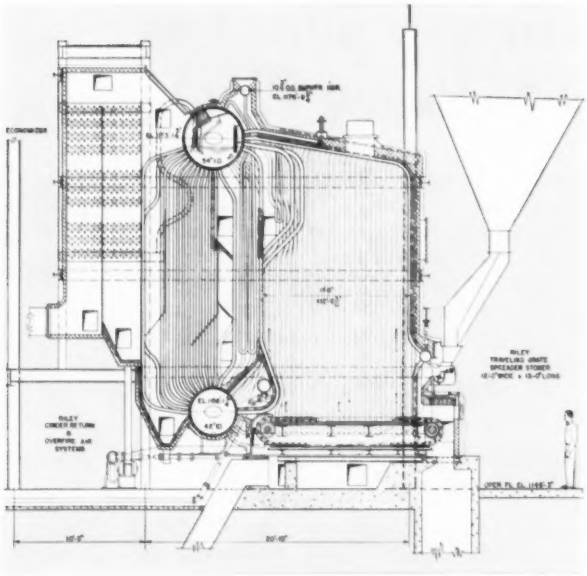
Prominent West Virginia Chemical Company
Replaces several low capacity, low efficiency units. Flyash reinjection eliminates flyash disposal problem, reduces carbon loss to minimum. Slag blowers not required.



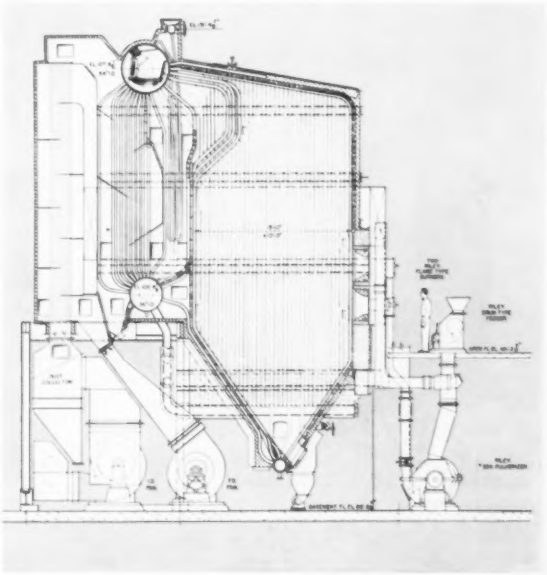
Western Electric Co., Hawthorne Power Plant
Three 200,000 lbs/hr Riley Boilers fired by Riley Pulverizers, Riley Gas, Oil, Coal Burners, Single Header Hopper, 1000 psig, 935 F.



Flintkote Company, Ridgefield Park, N. J.
One 60,000 lbs/hr Riley Boiler fired by Riley Pulverizer, Burners. Riley Air Heater, Single Header Hopper. 200 psig, 477 F.



Pennsylvania Railroad — Juniata Shops
Three 60,000 lbs/hr Riley Boilers fired by Riley Traveling Grate Spreader Stokers, 600 psig, 675 F. Riley Economizer. Cinder Reinjection.



Thomas A. Edison Industries, West Orange, N. J.
Two 60,000 lbs/hr Riley Boilers fired by Riley Pulverizers, Burners. 450 psig, 515 F. Patented Riley Hopper Bottom. Riley Air-Heaters.

A survey of your plant by a qualified consulting engineer could show ways of making surprising savings in your power costs.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

Allis-Chalmers Pumps Meet Power Plant Requirements

Continuous Condenser Service at Detroit Edison's River Rouge Plant

At River Rouge Station, these Allis-Chalmers 84 by 60-inch circulating pumps, driven by 500-hp motors, deliver 73,000 gpm to the A-C condenser.

They play an important part in assuring service continuity at this station. An accurately cast impeller, hand finished and dynamically balanced, assures smooth operation. Other features, including a rigid whip-free shaft, and tube-protected shaft and rubber bearings lubricated with filtered water, have made A-C circulating pumps popular throughout the power industry.

Many customers use Allis-Chalmers test facilities to properly design their intake structures.

You Get **MORE** than a Pump . . . When You Specify Allis-Chalmers

You can take advantage of Allis-Chalmers wide experience in supplying pumps to all industries. You are assured of modern design, heavy-duty construction and correct application aid — all adding up to many years of dependable service.

Allis-Chalmers is the only company that can offer you "One-Source" responsibility, with a complete unit — pump, motor and control — all built to work together. For "MORE" information about Allis-Chalmers pumps, call your local A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. A-5216

ALLIS-CHALMERS

Plant maintenance and management section

STEVE ELONKA
Associate Editor in Charge

ELECTRIC EYE near floor removes hazard of doors striking passengers or their pets

Automatic elevators: here's what they can do

By J N MILLAR
Millar Elevator Co

Many passenger elevators in commercial and light manufacturing buildings are out of date, need frequent repairs. At the same time, tenants demand faster elevators, less waiting. Often a streamlined appearance is expected, too. Now is the time to modernize. And with dependable operators harder to find, even at higher wages, trend is to automatic operation.

Today's elevator companies offer many designs to meet needs of each building. They have competent men who can determine adaptability of existing equipment to available innovations. A reliable company will give you a comprehensive report on what can be done, specifying replacements, makers' names, and availability of parts in case of emergency.

Best insurance of a good job is to check previous installations by companies submitting estimates. Were installations made considering requirements of their respective buildings? Are they giving service expected? Next step is to study estimates carefully. One may be attractive because it's low in price, another may seem exorbitant. An elevator installation should last for many years. The lower estimate may include inferior materials, indicating that quality was not a prime consideration in the estimate. This can result in expensive subsequent repairs and adjustments, or complete replacement of an unsatisfactory elevator. Such costs are generally far in excess of savings on original installation, not to mention inconvenience and unpleasant relations with tenants which ensue.

Popular types of automatic operation are described on pp 108, 109. Features which we recommend: To speed up traffic, consider *hallway landing doors*, whether single- or double-slide, bi-parting, or swing doors. *Load control* minimizes danger of overcrowding—device checks passenger weight; if 90 to 95% of registered load at main floor, doors close, and car answers first car call, but by-passes hall calls until weight is reduced. Other points: Use waterproof, fire-resistant cables; photoelectric cells for car-entrance protection; intercommunication system; illuminated buttons. Turn page

Intercommunication system

Two-way speaker-receiver set has become an important accessory for any emergency. A passenger can, by pressing a button, talk to receiving sets which may be located in any desired part of the building. Usually they are in the building manager's office and the motor room. Intercommunication also facilitates repairs; repairmen in car can report to others in basement, at top of hoistway, etc. Another passenger convenience, recommended where traffic warrants it, is double control, one station on each side of the car. Passenger in crowded car, seeing his floor has not yet been registered on side farther from him, can press button on the nearer side.

One of these systems of operation may provide

There are many variations on automatic operation from which you can choose. Twelve types described on these pages are all in common use today. New safety features which have been developed along with these types of automatic operation tend to make them safer than the manually controlled cars which they are gradually replacing.

Single automatic

Operation is by one button in the car for each landing served, and one button on each landing. Momentary pressing of landing button causes the car to start, if it isn't already in use, and has it stop at the floor corresponding to the button pressed. This is simplest form of automatic operation. It was the first to be developed and is widely used in all types of buildings.

Dual operation

With this system the elevator controller is arranged for either automatic operation by means of landing and car buttons or switches, or for manual operation by an attendant in the car. Attendant may use car switch or the buttons provided for automatic operation. When manually operated, throwing a suitable switch or switches prevents the car from being started by the landing buttons. These buttons are then generally used to signal the attendant.

Nonselective collective

This is automatic operation by means of one button in the car for each landing served, and one button on each landing. All stops registered by the momentary pressure of car and landing buttons are made in order reached, irrespective of number of buttons pressed or sequence in which they are pressed. Car stops at all landings for which buttons have been pressed, stopping in the order in which landings are reached, but irrespective of direction of travel. That is, a car going up continues to highest landing desired before descending, but opens for both up and down calls. This type of operation has the advantage that all calls are registered when buttons are pressed.

Dual nonselective collective

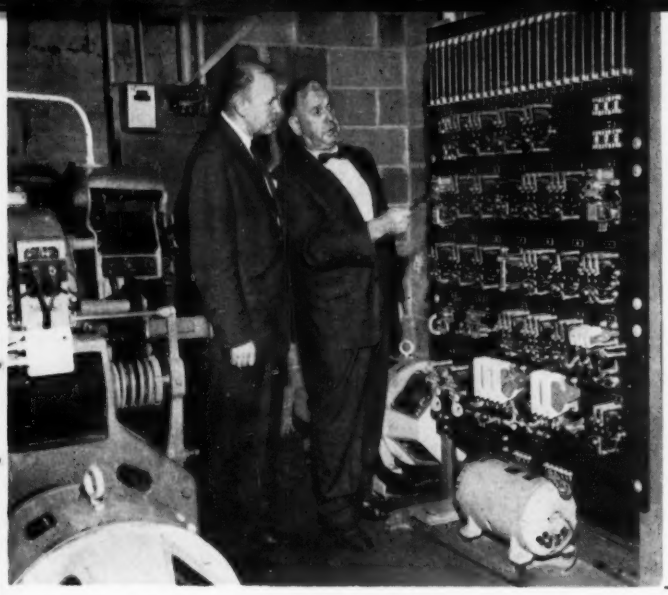
Features of nonselective-collective operation are in force when system is used automatically, but provision is also made for manual operation. This type of operation corresponds to dual operation with single automatic operation.

Selective collective

This is automatic operation by means of one button in the car for each landing, and by "Up" and "Down" buttons on each landing. All stops registered by momentary pressure of car buttons are made as described for nonselective-collective operation. Stops registered for the landing buttons are made in order in which landings are reached in proper direction of travel. All "Up" landing calls are answered when the car is ascending and all "Down" landing calls are answered when the car is descending. This system has considerable advantage in office buildings and hotels.

Dual selective collective

Manual operation can be provided in addition to automatic in which the selective-collective features are disconnected by suitable switch or switches. "Up" and "Down" buttons can be arranged to tell attendant direction desired by person pressing button.



Packaged control

Typical control system is of the variable-voltage type with a separate motor-generator set for each elevator. Acceleration and retardation are automatically controlled by varying the strength of the generator field. Field strength is controlled by pilot motor-generator or electronic control mounted with the control panel. Variety of control features including load control can be incorporated. Motor-overload protection is usually built in. New dc-drive motors are generally adaptable to existing mechanical-drive equipment, assuming latter is suitable for speed, acceleration of new elevator.

solution to your passenger-elevator problem

Duplex dual collective

Duplex collective operation is the automatic operation of two adjacent selective-collective elevators from a single set of landing buttons at the intermediate floors and at the terminals. One of the cars, called the *free car*, answers each call as it is registered. When there is a call that can't be conveniently answered by the free car, the second, or *home car*, is automatically called into service. The first car to complete its calls returns to the *home station* and becomes the home car. Dual operation, making it possible to operate manually, is usually combined with duplex-collective operation.

Signal control with attendant

Several elevators in a bank can be operated by relatively inexperienced attendant and with solid doors, since attendant does not need to see landing. Automatic-door operation is generally used. Signal operation is by means of single buttons in the car, and "Up" and "Down" direction buttons at the landings. Predetermined landing stops may be set up or registered for an elevator or group of elevators. The stops set up by momentary pressing of car buttons are made automatically in succession as the car reaches those landings, irrespective of direction of travel or sequence in which the buttons are pressed. Stops set up by momentary pressing of "Up" and "Down" buttons are made automatically by the first available car in group approaching the landing in the corresponding direction, irrespective of sequence in which buttons are pressed. The car can be started only by means of a starting switch or button in the car. Signal control operation was developed for use with banks of elevators in large commercial buildings and hotels.

Signal control without attendant

Operation is practically the same as signal-control operation, except that it is fully automatic. A predetermined interval allows passengers to board and leave car before doors close. Dispatching includes distinct programs to accommodate traffic demands which may vary widely during 24-hr period.

Traffic pattern control

Operating with or without attendant, supervisory system responds directly to traffic demand. Elevators maintain most efficient spacing for traffic at any time of day. Cars park and shut themselves down automatically during light traffic. Many elaborate functions can be incorporated.

Traffic master system

An alternative control system having essentially the same automatic features as automatic traffic-pattern control. System can be operated with or without attendant. It's not possible to enumerate in this short article the various features which are obtainable with this system; popular is indication of floors where waiting is long.

Corridor control

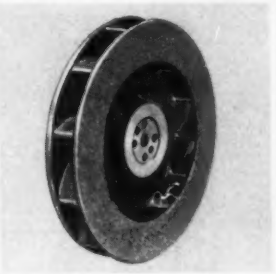
Fixture at each floor contains buttons for all other floors served. When button is pressed it's illuminated, indicating a call has been registered. It stays illuminated until car stops at floor, where doors open for predetermined time while passenger boards car. When doors close, car travels to designated floor and doors open without further action of passenger. If calls are registered while car is in use, it makes stops in direction of travel, reversing at farthest stop.

OPERATORS' NOTEBOOK **116**

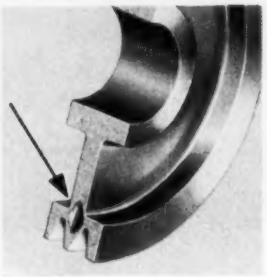
Here are ABC's of

Balancing machine at work

These causes of unbalance are common

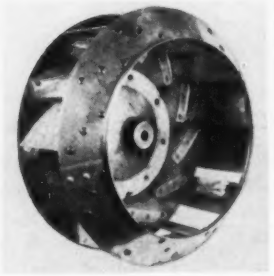


1—Nonsymmetry

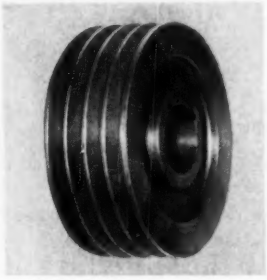


2—Nonhomogeneity

3—Nonsymmetry



4—Body distortion



5—Poor distribution

6—Variation in mass

Causes and cures of unbalance

Here are six common causes of unbalance: (1) Portions of castings or forgings are not machined, Fig. 1. (2) Lack of homogeneity in all materials, whether cast, rolled, forged, formed, extruded, etc. Fig. 2 shows blowhole in machined cast-iron sheave. (3) Nonsymmetry in products caused by limitations in design, or fabrication, Fig. 3. (4) Nonsymmetrical distortion of a body while running at its operating speed, as shroud ring or blades of blower fan, Fig. 4. (5) Nonsymmetrical distribution of mass due to tolerances allowed on all machine surfaces, Fig. 5. Here tolerance is 0.002-in. runout for outside diameter with respect to bore. (6) Variations in distribution of mass in the rotating assemblies, as crankshaft, Fig. 6. So, unless parts are balanced, rotating parts vibrate, cause bearing trouble and even destroy the machine. Let's see what this unbalance force can amount to.

Unit of unbalance. Unbalance of 1.0 oz in. is produced by a 1.0 oz weight displaced 1.0 oz from rotational axis. Rotor weighing 62.5 lb (1000 oz), mass center of which is 0.001 in. from rotational center as determined by its bearings, is 1.0 oz in. out of balance. Product of weight, 1000 oz, and displacement of mass center, 0.001-in., equals 1.0 oz in., or 1000 oz × 0.001-in. = 1.0 oz in.

Force exerted by unbalance. Unbalance of 1.0 oz in. at 500 rpm produces 0.443 lb centrifugal force. At 5000 rpm, a 10 times greater speed, centrifugal force is 44.3 lb, a 100 times greater centrifugal force. At 50,000 rpm (common speed in many types of machines today) centrifugal force caused by an unbalance of 1.0 oz in. is several tons—4430 lb.

Types of balancing. Static balancing requires only a single correction weight to rotor, Fig. 7. Dynamic balancing needs two correction weights, each in proper positions in separate planes spaced some distance apart and perpendicular to the rotational axis, Fig. 8.

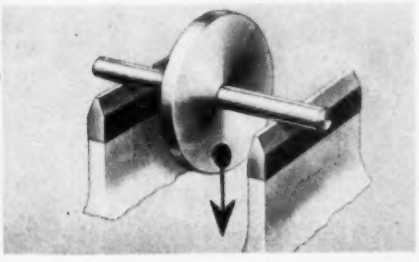
Rotating parts usually have both static and dynamic unbalance, Fig. 9. Here two equal weights near ends cause dynamic unbalance and third weight introduces static unbalance. Such combined static and dynamic unbalance can be corrected by weights placed in two different planes, perpendicular to the axis of rotation.

Balancing machines. Balancing is a process of altering distribution of mass in a rotor to eliminate vibration at supporting bearings. Two steps are to (1) locate and

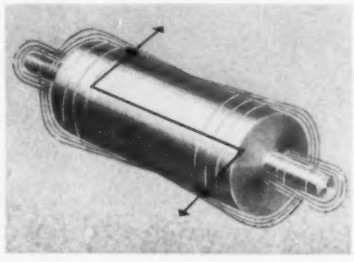
balancing rotating parts

By STEVE ELONKA, Associate Editor

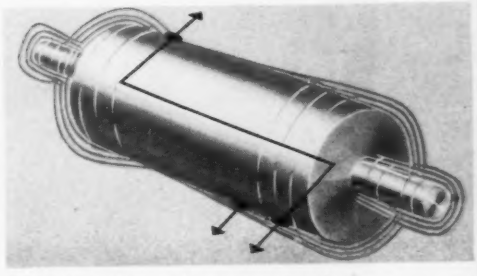
Some types of balancing operations



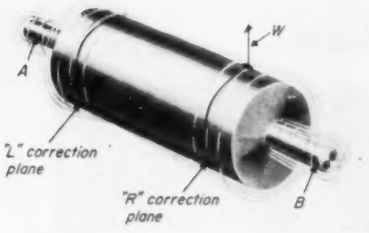
7 Static balance is observed by mounting unbalanced part on knife edges



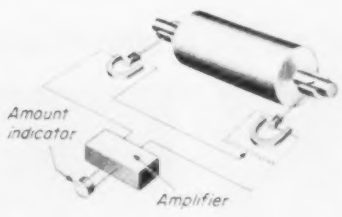
8 Dynamic unbalance is caused by equal weight on rotor's opposite sides, ends



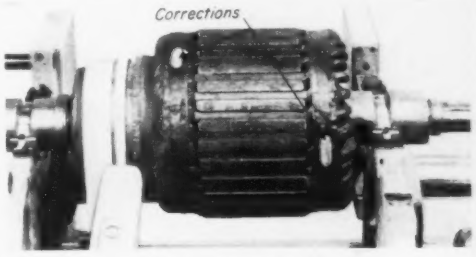
9 Static and dynamic unbalance has three weights distributed as shown on rotor



10 Separation of unbalance effects falls into two correction planes, at *L* and *R*



11 Electrical method is used to measure degree of unbalance and correction



12 To correct unbalance, apply solder to rotor banding wires of dc motor rotor

measure corrections needed and (2) apply corrections.

Correction for dynamic unbalance must be made in two planes perpendicular to axis and spaced some distance apart. A good balancing machine must indicate directly amount and angular location of correction needed in each of two planes, Fig. 10. To give direct indications of corrections in each of two selected correction planes, machine must have certain elements. For example, in Fig. 10, cylinder is rotating and is supported very flexibly at *A* and *B*. *L* and *R* represent the two selected planes in which corrections can be made. Cylinder has only one unbalance, *W*, which we placed in *R* correction plane. As piece rotates, unbalance *W* causes vibration at bearing *B*. It also causes vibration at bearing *A*.

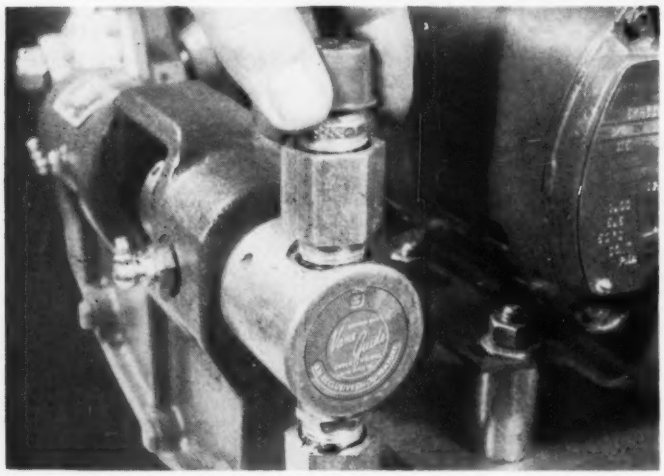
To balance piece perfectly you need correction only at plane *R*. If unbalance is present in both planes, motion of bearings *A* and *B* are complex—vibration of each bearing is caused by unbalance in both correction planes. Unless separation is interposed between bearings and unbalance indicating device, you can't get direct indications of unbalance in either plane. Bearing's motion alone can't be used as a measure of unbalance. So machines using only bearing motion for this purpose are trial-and-error or guessing devices.

Electrical method. Machine using electrical method measures amount of unbalance and amount of correction needed, as shown schematically. Here you have no lost motion between vibratory support and the amount indicator, as exists in purely mechanical machines. This permits use of any practical rotation speed for the workpiece, avoids problems of friction, assures stability of performance and precise readings of the amount indicator.

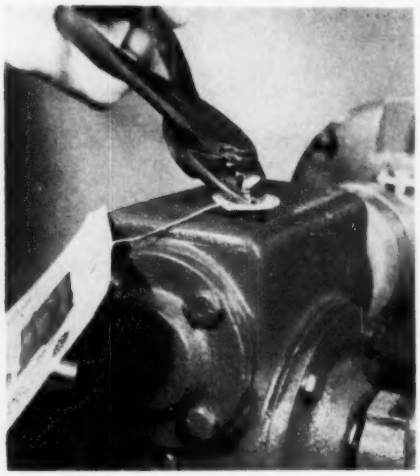
Output of machine's net work is led into an amplifier before reaching amount indicator. This amplification can be 1,600,000 times or more, and is easily varied to meet each job. Result is a definite stable meter indication large enough for precise reading of unbalance.

Correction methods. While balancing machine indicates precise size and location for correction, balancing isn't complete until corrections are made. You can correct by adding or removing weight. Fig. 12 shows weight added to rotor. You can remove it by milling, grinding, shaping, drilling, etc. Send for 36-p brochure: "Balancing Machines."—*The Gisholt Machine Co, Madison, Wis.*

Protection should start from the day you uncrate the pump

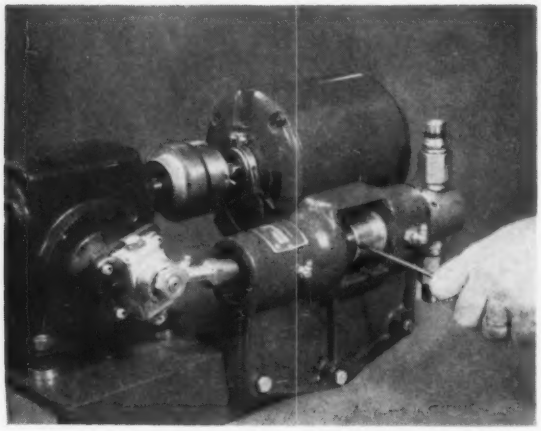


PLUGS OR CAPS are usually fitted over check valve parts by the manufacturer. *Don't* remove these until you are ready to install the piping. Liquid ends are designed with close volumetric clearance. Be sure to keep foreign matter out

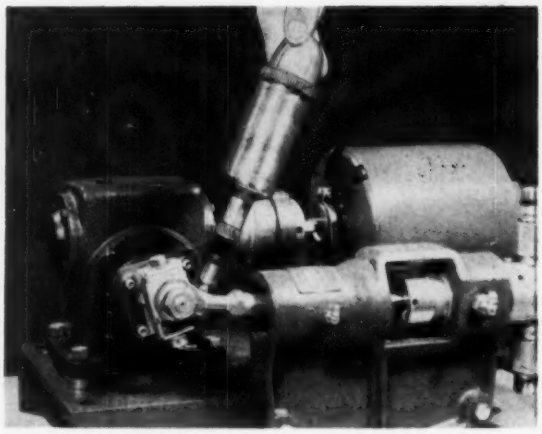


SPEED REDUCER oil-seal leakage results from failure to vent reducer. Many pumps are shipped "wet" with vent plugged. Remove plug before start-up

But performance will depend on the attention you give it



PACKING is adjusted at the factory during the testing and run-in periods. However, the first 24 hr of "on-the-job" operation are critical. If packing leaks, pull up the gland very gradually

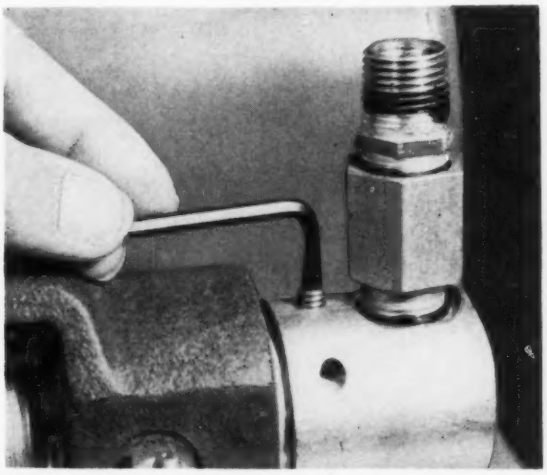


LUBRICATION POINTS are few, but vital. Bored connecting rod on some pumps permits one-point lubrication of both crank and wrist pins. Crosshead piston and packing are other important spots

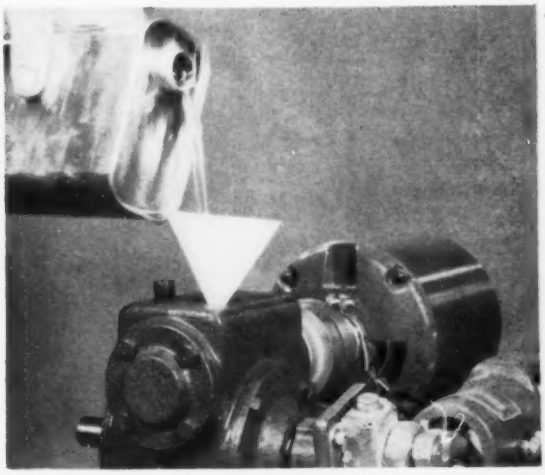
If you want your boilers treated right, then...

Treat your chemical feed pumps right

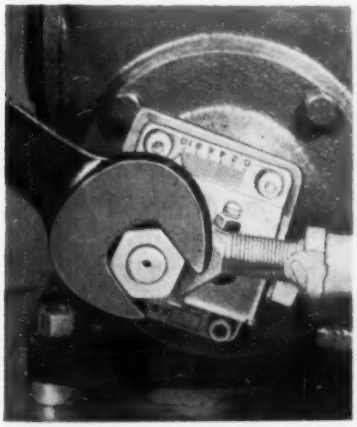
By E R FRANKLIN, Project Engineer, Proportioneers, Inc, Div of B I F Industries, Inc



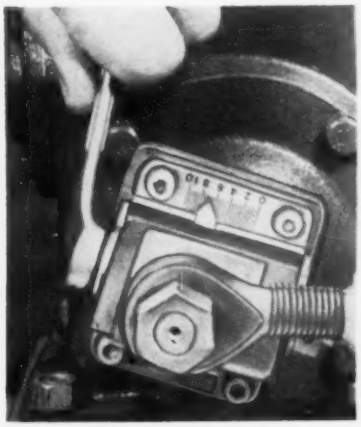
PURGE AIR from pump cylinder at start-up until no bubbles can be seen in the vent discharge. Do it either with a vent valve in discharge line or the ball check built into the cylinder, *above*



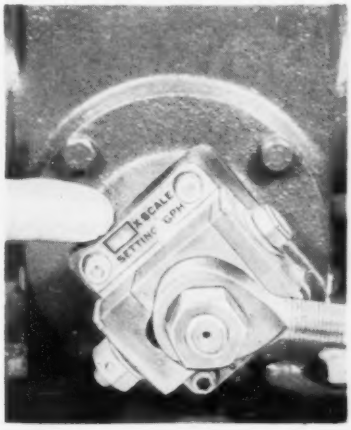
DOUBLE CHECK the oil level. Though many pumps are shipped "all ready to go," don't take this for granted. Another important hint: flush reducer and change the oil after the initial run-in



VARIABLE STROKE is important feature. Before changing stroke, crankpin locknut must be loosened. Don't use pipe wrench



LEAD SCREW changes stroke length, delivery. If lock screw, *previous photo*, isn't tight after adjustment, pump will fail



REFERENCE to the percentage calibrated scale, *previous photo*, and capacity scale, *above*, will indicate pump's delivery rate

Do you appreciate the part chemical-feed pumps play in plant performance?

The chemical proportioning pump's role becomes increasingly important in today's power plant. Efficient use of available chemicals can mean a sharp drop in maintenance expense chargeable to steam generators and piping systems. Using these chemicals efficiently means having an accurate, dependable instrument for introducing them into the feed system, steam piping or the boiler itself.

The small pumps designed to do this job are vital links in modern plant operation. Yet, probably no piece of pumping equipment in the plant is called upon to perform under more adverse conditions. The need for proper installation is apparent; the need for proper maintenance can't be emphasized too much.

NOW, TO CHECK THESE IMPORTANT TIPS ON HOOKUP AND MAINTENANCE, TURN PAGE ▶

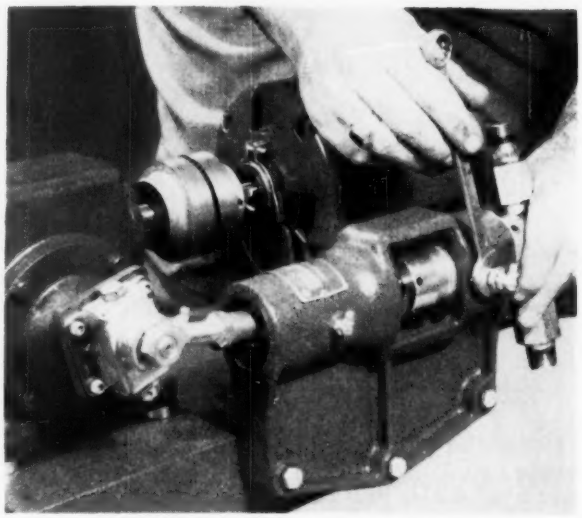
Scheduled inspection is the answer to forced shutdown

Factors other than those shown on the previous pages can make or break pump performance. Examples: keep suction lines short, provide a flooded suction, use self-cleaning strainers, avoid leaks. Remember, this is a precision pumping instrument. Friction caused by lengthy, undersized or starved suction lines will greatly affect the pump's accuracy. Foreign matter must be kept out of the liquid end. And air leakage into the pump is perhaps one of the worst single enemies of accurate output.

Discharge piping, too, must be adequately sized —in this case to prevent excessive pressure build-up. This is particularly important where a pump may have a maximum pressure rating only slightly above the pressure at the point of injection.

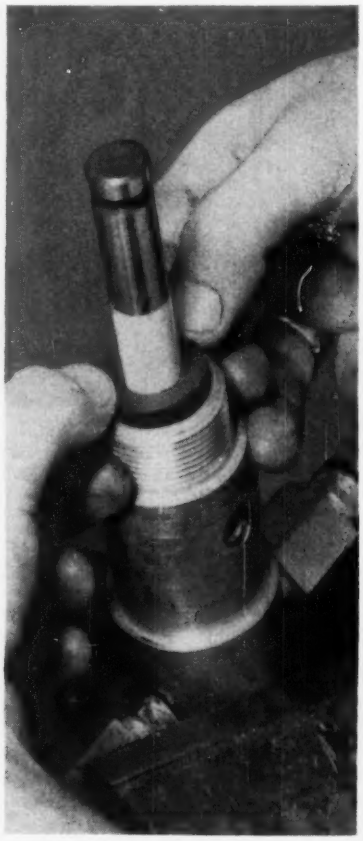
Install a relief valve close to the pump discharge port. Pipe valve discharge to top of chemical tank, *not* to pump suction. It's important that you know of any valve leakage.

Good installation is half the battle. Add good maintenance and you'll have a trouble-free system.



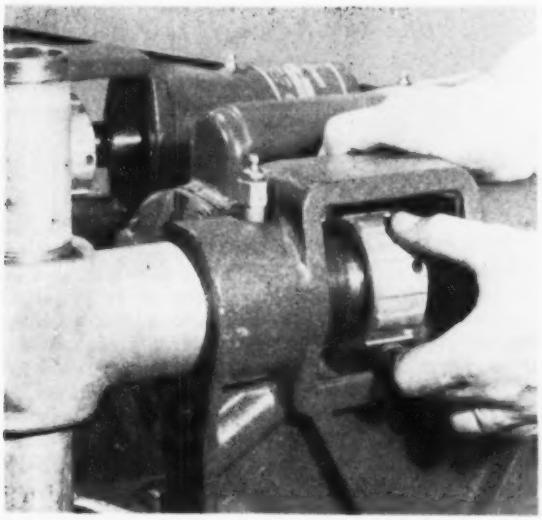
MOST VULNERABLE parts of your pump are plunger, packing and check valves. Keep them in top shape. Liquid end of many pumps is easily removed. To do so, remove retaining plug, *above*

STUFFING BOX is easier to get at with head removed. Remove all old packing. Don't miss rings forward of lantern ring

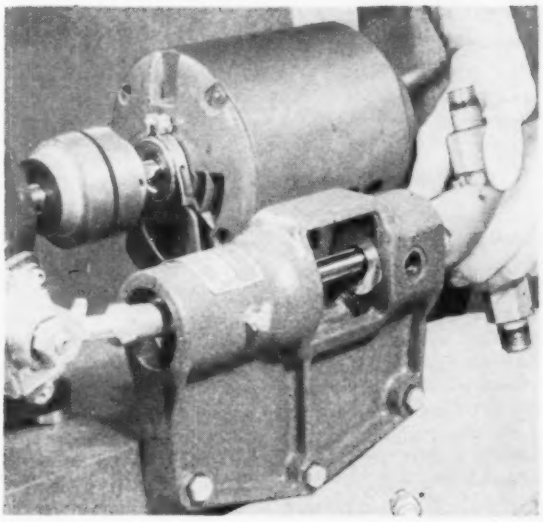


REPACK stuffing box with plunger in place. This is a good chance to inspect plunger. If it's scored, best bet is to replace it

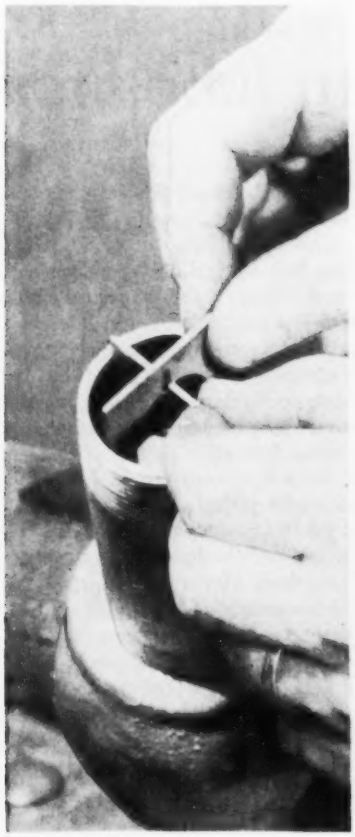
CHECK VALVES should be disassembled for ball and seat inspection. If worn, it's a wise move to replace these critical parts



GLAND FOLLOWER should then be backed off carefully. Most followers have holes to take a key for starting first ½-turn or so. If follower is hard to loosen, it has been pulled up too tight



LIQUID END can now be slipped entirely away from the pump frame. Important thing to remember here is that you're dealing with the pump's "heart." Handle it carefully, keep work area clean

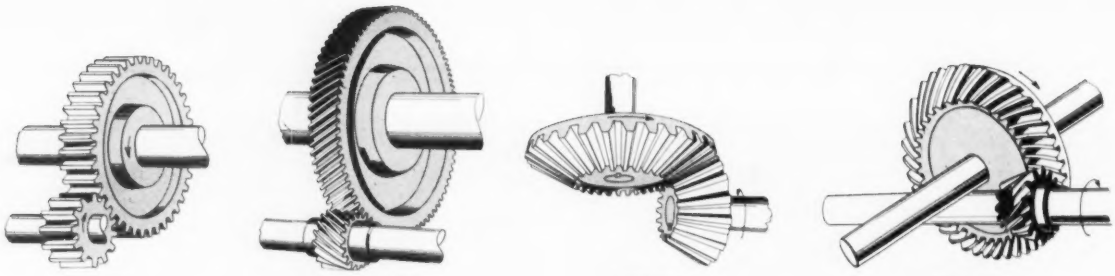


DISASSEMBLY. After removing the retaining ring, shown in previous photo, carefully slip vane guide from valve body

VALVE SEATS should slip easily from body. If tight, tap gently with *brass* bar stock. If threaded, use seat wrench designed for it

SEATS, if worn, can be reversed on some pumps, may require replacement on others

SERIAL NUMBER is important. Use it when contacting pump manufacturer. He can identify pump fast, give quick service



SPUR HELICAL BEVEL HYPOID

COMMON GEAR TYPES in use today include spur, helical, herringbone, straight and spiral bevel, hypoid, single- and double-throated worms. In most respects these gears are the same as they have been for many years. Yet refinements in design and manufacturing methods have reduced cost, noise, size and weight.

Some gear-manufacturing sequences in common use today are: (1) Cutting; hardening to medium hardness; finishing by shaving, lapping or grinding. (2) Cutting; finishing by shaving, lapping or grinding; hardening by the flame or induction processes. (3) Cutting medium-hard steel; shaving or grinding; case hardening by carburizing, nitriding, induction, or flame processes; lapping. (4) Hardening to low hardness; cutting; shaving or lapping.

Gears of various materials are also made by single processes such as cutting, broaching, punching, grinding, sandcasting, die casting, injection molding (of plastics), investment casting, sintering (of metal powders), cold-drawing, extruding, cold rolling (of worm threads).

Many machines and techniques associated with these processes have been substantially improved over the years. To mention just a few: Smaller gears are cut automatically today in mass-production shops. Operator does nothing but bring blanks to a machine and take away finished gears.

PART I OF A SERIES. By E S REYNOLDS and J R HICKS, Socony Mobil Oil Co, Inc

Today's gears need modern lubes for

Today's gears are better than ever. As mentioned above, they cost less, make less noise, carry more load for a given size and weight than gears of a few years ago. But they are still subject to failure if improperly lubricated, poorly installed or overloaded.

This article, first in a series of four, describes gear lubrication. Succeeding articles will be devoted to causes of gear failure.

Effect of gear type. Gear type alone is an important factor in choosing the proper lubricant. Tooth-contact patterns may favor lubricant film formation or make it difficult.

Upper right sketch, page 117, shows typical contact patterns for principal gear types. We speak of the "line" of contact, but because of elastic deformation under load tooth contact is actually a band. With spur gears, first contact is between tip of the driven tooth and lowest active part of the driving tooth. Line of contact then sweeps from root to tip on driver and tip to root on driven tooth. This sweep of the contact line at right angles to itself is favorable to lubricant film formation.

Spur-gear teeth roll and slide together in going through mesh. Rolling occurs throughout mesh, but the rate of slide varies from maximum at the start of mesh to zero at the pitch line and again to maximum at the end of mesh. The contact is pure rolling at the pitch line.

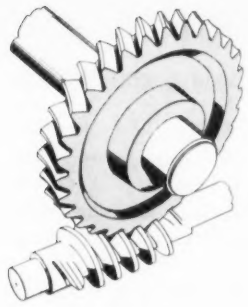
The sliding action, at right angles to the line of contact, aids lubrication by dragging oil into the pressure area. The rolling action also promotes lubrication, since tooth surfaces continuously roll onto thick oil films.

Tooth action with straight-bevel gears is much the same as with spur gears. With helical (and herringbone) gears, the pattern of contact is a curved line. But tooth action is similar to that of spur gears, and the sweep of the line of contact nearly at right angles to its length also favors lubrication. Spiral-bevel gears are comparable to helical gears with respect to lubricant film-forming conditions.

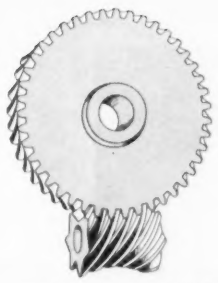
This entire group of gear types—spur, helical (and double helical and herringbone), straight and spiral bevel—is relatively easy to lubricate.

Worm gears are another story. Worm-gear teeth are based on involute teeth, but modified in various ways. These modifications and the reduction ratio affect pattern of contact. If the worm were moved back and forth as a rack and not rotated, line of contact would move from tip to root on the wheel as with spur gears. This would favor film formation. This movement of the line of contact does take place, but worm rotation adds a high-velocity side slide, more or less along line of contact. Because of side slide, the contacting surfaces tend to break through the lubricant film, making lubrication difficult.

Hypoid gears operate on shafts that are at an angle (usually 90 deg) but do not intersect. If offset between shafts is small, hypoid gears resemble



WORM



DOUBLE-ENVELOPING WORM

Equipment, including quenching presses, is now available for fully hardening gears over 25-in. diameter. Also, larger and larger gears can now be ground. A Maag gear-grinding machine handles gears up to 142-in. p.d.

Increasing the hardness of steel gears raises the fatigue endurance limit and permits the designer to use higher surface stresses—that is, heavier surface loads. Thus, gears can be smaller for a given load and speed.

Trend toward reduced size for a given horsepower has resulted in higher tooth loads and higher operating temperatures. Meeting these more severe conditions requires substantial improvements in lubricants as described below.

Typical tooth-contact patterns

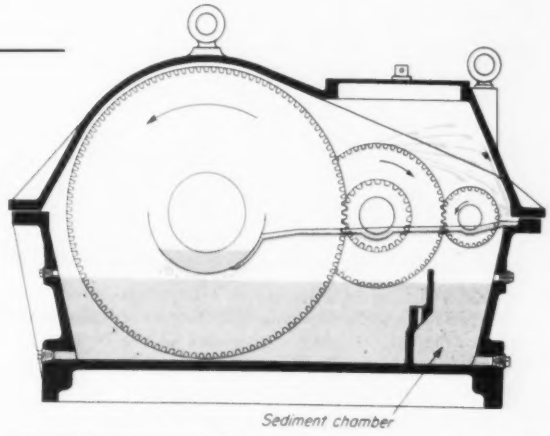
PATTERN of contact between mating teeth varies with gear type. For spur and straight bevel gears it is a straight line; for others, a curved line as shown above

long life

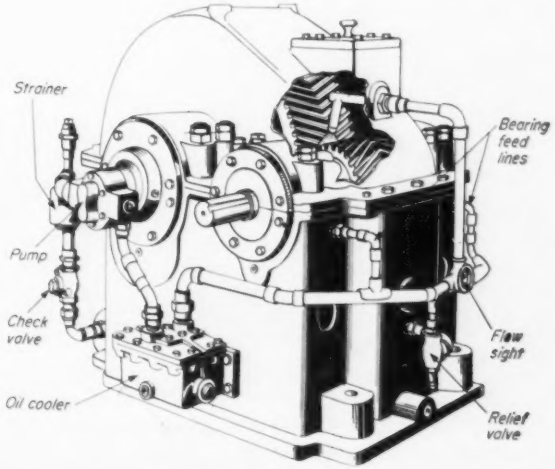
spiral-bevel gears and have similar characteristics as far as lubrication is concerned. On the other hand, if the offset between shafts is large, hypoid gears take on some worm-gear characteristics. There is a high side-slide velocity, more or less along the length of the contact line. Because of this effect, where loads are heavy, these gears are more difficult to lubricate than the spur-helical-bevel group.

Lubrication methods. Most enclosed gears are lubricated by splash or pressure-circulation systems that use the same oil over and over again. Some machine tools, especially those having vertical spindles so oil leakage is a problem, use the oil-mist system. This is an all-loss system; oil is not reused.

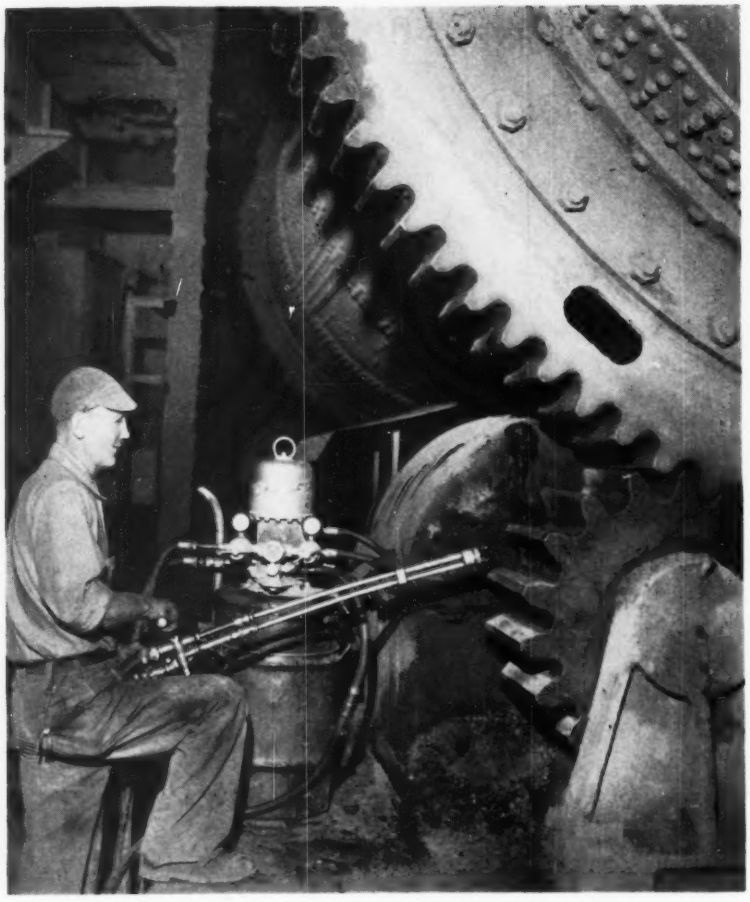
Splash lubrication, see sketch at right, is the simplest type. It is satisfactory for industrial gears of all sizes and speeds up to pitch-line speeds of about 3000 fpm. In sets operating above 2000-fpm pitch-line speed, oil-bath level must be carefully controlled



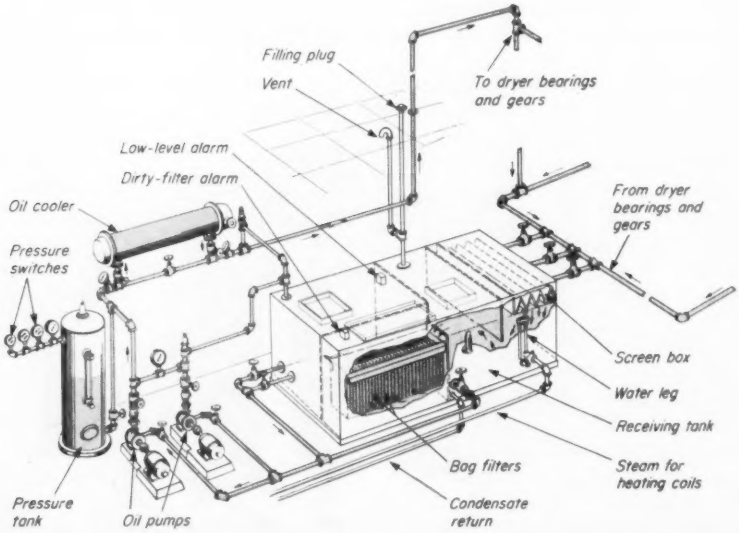
SPLASH LUBRICATION. One or more gears dip into an oil bath and carry lube to meshing teeth. Oil also splashes to bearings



PRESSURE CIRCULATION. Pump draws oil from reservoir in gear-case base, delivers it under pressure to bearings, gear teeth



OPEN GEAR LUBRICANT is frequently sprayed on with portable power-spray equipment. Good use of system provides even distribution on gear face with minimum lubricant waste



CENTRAL CIRCULATION SYSTEM, used for large machines. Purification equipment, means for keeping dirt, water, etc out of system keep oil in good condition for long life

Viscosity, oxidation

to prevent too much churning and misting of oil. In no case should oil level fall below an established minimum as lack of lubrication may result.

Pressure circulation can be applied to enclosed gears of all sizes and speeds, and should definitely be used where pitch-line speed is over about 3000 fpm. The simple self-contained system (bottom, page 117) shows the essential elements: reservoir, pump, piping, pressure-control (relief) valve and spray nozzle. An oil cooler is often needed, and good practice requires the use of a strainer on the pump suction and a full-flow or bypass filter on the discharge side of the pump.

The spray nozzle, directed to the incoming side of mesh, should provide a flat spray that reaches the full width of the gears. Several nozzles may be necessary for wide-face gears. Some designers direct the spray nozzles toward the outgoing side of mesh at higher speeds. They believe that better cooling is obtained. For maximum cooling, and where gears must turn in either direction, sprays are directed to both sides of mesh.

A central circulation system, bottom sketch, at left, is used where many related gear drives are strung out along a machine such as a rolling mill or paper machine. Large systems contain thousands of gallons of oil. Appropriate purification equipment and means for keeping dirt, water, etc from entering the system keep the oil in good condition. In large, well-cared-for systems, oil may remain in service for 20 or 25 years.

Oil-mist lubrication creates an air-oil fog in which the oil particles are so fine that the fog hardly wets metal surfaces. Such a dry fog can be distributed through long lengths of tubing, around bends, etc with little oil loss. At the point of use, impingement on rapidly moving parts has a coalescing effect. Fine oil droplets join to form larger droplets that wet the metal surfaces and provide lubrication. Anti-friction bearings and gear teeth moving at 350 fpm or more can be lubricated this way. At lower gear speeds, special fittings are available for condensing oil fog into a spray.

Open-gear lubrication. Some

stability: two of the important characteristics in a gear oil

open gears have no housing except safety or splash guards. Others have complete dusttight housings, but in no case is the housing oiltight so a circulation system could be used. Many lubricant-application methods have been used including brush, paddle, drop-feed cup, mechanical force-feed lubricator, slush pan, grease gun or calking gun.

Some open-gear lubricants are heavy, adhesive materials that are made fluid by adding a volatile nonflammable diluent. After application the diluent evaporates, leaving a tough plastic film that is effective even though very thin. Most efficient and economical way of applying these lubricants is by spraying. For large open gears portable power-spray equipment, such as that shown in photo, p 118, is very satisfactory. Permanently mounted power-spray equipment is also available. Lubricating cycles are controlled manually or automatically.

Oil selection is truly a field in which there is no substitute for experience. Oil suppliers and gear manufacturers are always willing to help. Factors to consider in choosing an oil for a particular gear set include: (1) gear type (enclosed: spur, helical, bevel, worm, hypoid; open) (2) pinion speed (3) horsepower (4) nature of load (steady or shock) (5) method of oil application (6) reduction ratio (and whether single or double reduction) (7) oil temperature (minimum starting to maximum operating).

A few examples will show how these factors affect the need for various oil characteristics. For circulation systems of any type, the oil characteristics of most importance are viscosity, oxidation stability, film strength, water-separating ability, anti-rust property.

Viscosity is the most important fluid property. It plays a part in distribution to bearings and meshing gear teeth, in lubricant film formation, in cooling and in settling of dirt and water in the reservoir. In selecting an oil of correct viscosity, consider the temperature range and method of application.

With a pressure-circulation system, viscosity at the starting temperature of oil in the reservoir should not be more than about 15,000 ssu so oil will flow freely into the pump suction. Lowest permissible viscosity at the highest operating temperature depends on pinion speed and load. For example, for over 20 hp and under 1000 rpm, the viscosity should not be less than about 150 ssu. For high-speed sets, which are usually lightly loaded, the viscosity at the highest operating temperature can be as low as about 50 ssu. Where temperature range is wide, use oils whose viscosity does not change much as temperature changes. Such oils are said to have high viscosity index (often abbreviated as high V.I.).

With splash lubrication, where the oil is directly agitated by one or more gears, starting temperature viscosity can be much higher than with pressure circulation. In fact, rather than viscosity, the channel point of oil is the limiting factor. This point is the temperature below which oil will not slump into the path of a gear so it can be picked up. Channel point of a gear oil usually runs 20 to 30 F below its pour point. On the high temperature side, where pinion speed is less than 1000 rpm and load is over 20 hp, viscosity at highest operating temperatures should not be less than about 250 ssu.

With an oil-mist system, the oil should not be so heavy at the temperature around the lubricator that it will not mist properly. According to one system manufacturer, viscosity at that temperature should not exceed about 2000 ssu.

In most enclosed gear sets, both gears and bearings are lubricated by the same oil. The gears usually require a heavier-bodied (higher viscosity) oil, and that fact determines the selection of oil. Similarly, where there are two or more reductions in a set, the low-speed pinion and its mating gear require a heavier-bodied oil than the higher-speed gears. This requirement guides the oil selection for the set.

Oxidation stability is the measure of oils' ability to resist oxidation and resultant sludge formation and gradual increase in viscosity. Oils that have high oxidation stability are capable of long life in circulation systems. Modern circulation-type gear oils contain oxidation inhibitors that interrupt the oxidation process and reduce the oxidation-promoting, or catalytic, effects of metals.

Nonetheless, the oils must be kept clean in service. This is accomplished by preventing contamination as far as possible and by removing contaminants through suitable purification equipment. Also, operating temperatures should be carefully controlled, since the tendency for oil to oxidize increases rapidly at higher temperatures.

An inhibited oil that is especially suitable should have a combination of oxidation inhibitors effective both at normal temperatures and at higher temperatures for which the oil is recommended.

Film strength. Even when gears operate on fluid films so there is no metal-to-metal contact between teeth, the films are very thin. As loads increase, they reach a point where tooth surfaces can no longer be completely separated. Minute "hills" of the mating surfaces contact each other. Some of these hills plow through and deform each other. Some break off or are rubbed clean, and minute welds are likely to form where clean surfaces come together.

The welds break immediately, but not necessarily at the place where they formed. As a result, metal transfers from one surface to the other and surfaces are damaged. Under this condition of partial boundary lubrication, oil film strength or anti-wear value, becomes very important. Suitable oils contain additives that form strong films on the clean metal surfaces, usually by chemical action. These films reduce actual metal contacts and wear, yet offer low resistance to shear so friction is low.

Gears of heavy-industry machines such as rolling mills, rubber mills and metal-forming presses need even greater load-carrying ability. Tooth loads are heavy and shock loading is usual. Oils for these applications contain additives called mild "extreme-pressure" (E.P.) materials, such as lead naphthenate and sulfur. Better products of this class also have good oxidation stability, are capable of long service life (*Continued on page* 232)

Super-clean plant areas a headache?

With research and development assuming greater importance, plant engineers in growing numbers can expect to be tapped for the job of converting some portion of an existing plant's facilities into suitable R & D quarters. And where the end product involves delicate instrumentation you may well be wrestling with super-clean and vapor-controlled areas.

A truly modern and model setup that might well serve as a guide was recently unveiled by Federal Telecommunications Lab in San Fernando, Calif. Here's what they got.

Three distinct R & D areas make up the package: (1) A super-clean section for assembly and testing of micromechanical devices such as gyroscopes (2) A vapor-controlled area where the air intake is drawn from a 40-ft tower simply to reduce contamination from auto exhaust gases (intake is then treated to control vapor content, especially those given off from experiments in adjacent areas). (3) A universal area which can be quickly converted from private to semi-private offices, to flexible and efficient electronic labs.

Dust and air temperature control is critical where development and testing of high-precision gyroscopes is carried out. And humidity should be fairly low to avoid rust and perspiration. So the super-clean rooms in this newest FTL lab are built to keep out all dust particles while holding temperature at 71 F, ± 1 deg. Humidity is held below 40%.

How is this done? Well, let's follow the complicated procedure a lab man goes through on entering the super-clean gyro test rooms:

He first enters a small air-lock painted glossy jet black. Lighting level here exceeds 400 ft-c. An all-black room lets dust particles stand-out more clearly than they would in a conventional white or light-colored room. Slight positive pressure in the air-lock prevents outside air from leaking in.

Once inside the lock, the lab man vacuums his clothes with a gadget connected to a central vacuum system. He slips each foot into an automatic shoe-cleaning machine where dirt buffed off the shoe is sucked away through the same vacuum scheme. Then, after slipping into lint-free clothing including a cap, and rubbing lotion on neck, hands, wrists, eyebrows to prevent chapping and skin flaking in the low humidity, our lab man goes onto a second air-lock. There, air pressure is higher than in first chamber, ruling out any influx of air currents. A gelatin mat covers the floor, picking up remaining dust from shoes. His last move is into the super-clean room where ambient pressure is at a still higher level.

Within test rooms, walls and ceilings are surfaced with high-gloss, nonporous vinyl enamel. Floors are of continuous vinyl-plastic sheeting rather than individual plastic tiles. This design rules out the many cracks between single tiles. Plate-glass view-panels built into one wall permit outside observation.

Both super-clean test rooms are alongside an oscilloscope room so a single technician in the scope room can assist in both test rooms. Remote operation of test equipment is provided for by windows and control cables.

Built into one corner of the gyro assembly room is a cleaning booth with an odd-looking revolving fixture built into the wall. This fixture, somewhat akin to a bank's night depository opening, is an airtight pass-through to a precision machine shop which qualifies as a clean-room itself.

Across the hall from the super-clean gyro rooms are five somewhat similar appearing rooms tabbed vapor-controlled rooms. Since these five rooms are intended for solid-state research, where control of all vapors is critical, they are designed with less attention to dust and more fuss about vapors. As mentioned, all air used in the vapor-controlled rooms is drawn from an inlet atop the tower. Input is electronically filtered, water washed, filtered through activated carbon to absorb remaining traces of organic vapors.

Then, since water vapor itself is an important element of the atmosphere, its percentage is carefully controlled. It would be unwise, medically, to eliminate humidity; so it's held reasonably steady at 22%.

Flooring in the vapor-controlled areas get special attention too. Asphalt tile and vinyl sheeting give off traces of organic fumes, so they're not used. Inorganic terrazzo was chosen instead. Same kind of careful selection goes into choosing wall paint; one with a low vapor tension was selected.

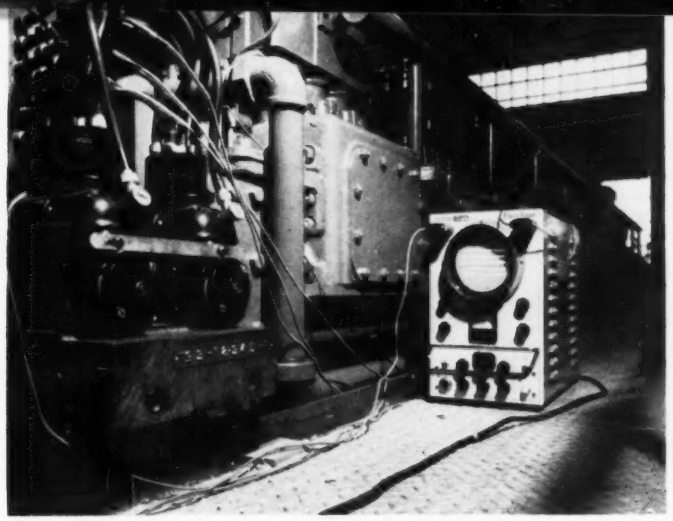
This outline should serve to flag you on the size of the problem faced in laying out closely controlled instrument research and test areas.

Pumpless ignitrons span decade

A decade of successful use of pumpless ignitrons in electro-chemical pot lines, steel mill drives and other industrial applications has been racked up both in the U.S. and abroad. More than 3000 of these rectifiers have been installed since 1948.

During the General Winter Meeting of AIEE, W L Blatz and E J Remscheid of General Electric reported that of the 3000 installations, about 1% were found defective during time of installation and less than another 1% failed while in service. The GE men stated further that all failures in service could be traced to external accidental causes.

The pumpless ignitron is an evolutionary product of the older pumped-type mercury arc rectifier; a device in common use up to the mid 1930's. This was gradually superseded by the pumped ignitron and the sealed pumpless unit. Latter boasts a higher efficiency because of lower arc loss. And it costs less to make.



Scanning engine troubles

Television-like analyzers are taking a cost-cutting look at the inner mechanical operations of industrial engines, without need for expensive shutdowns. Both Sperry Gyroscope Co and the Allen B Dumont Labs are marketing a portable trouble-spotter which allows the operator to pin down troubles in short order.

Dumont unit, above, tagged an *EngineScope,* was designed with the spark-ignited engine in mind, whether magneto or battery is used. Trouble is pinpointed by cylinder comparison. Each cylinder operation, from the firing of the spark to the opening of the points, is shown on the television-like picture screen; one line below the other in the engine's exact firing order. Instrument can be connected to engine while machine is operating. This feature eliminates need for disturbing system of piercing wires. Typical faults: fouling, misfiring, open or shorted sparkplugs; defective coils, condensers; wiring and switches, to mention a few.

Sperry's unit handles diesel and spark-ignited engines. Basically, this analyzer provides three types of data: ignition, vibration and pressure. Functional information is presented on a 5-in. oscilloscope while engine is running, loaded or unloaded.

New frequency multiplier bids in

There have been many attempts over the years to develop a really practical frequency multiplier (POWER, Sept 1957, p B-185). And numerous circuits and magnetic configurations have been proposed. Now by simply combining a known circuit with a new stabilization system and improved magnetic materials, a practical frequency multiplier can be built. The basic circuit is capable of multiplying frequency by any odd integer.

According to Westinghouseman R A Stuart at the AIEE Winter General Meeting, this new static frequency is suited for applications demanding a higher than supplied frequency while sidestepping maintenance problems of rotating equipment. Briefly, such a device is a transformer-like unit that can be built with standard parts and methods. Case-in-point is a seven times multiplier having a power output of 1350 watts, 83% efficiency, 0.70 pf leading and an output voltage regulation of 10%. It could well be used to deliver power for high-frequency lighting, electroluminescent panels.

Plant power demand can be a costly operating item

Tying in industrial plant generators with utility lines has some distinct advantages, but not without posing a host of potential electrical problems. Some are routine and have been faced and mastered in many plants. Others can be toughies.

Routine jobs, that pop up when interconnected, start with the mechanics of phasing in the plant's turbines to the utility lines if any separation occurs. When the power company lines go out, again it's a somewhat mechanized procedure to be followed in maintaining service during the outage period. Helping the power company electrically when needed, assuming you can, requires good operating judgment plus a clear understanding of the switching procedure involved.

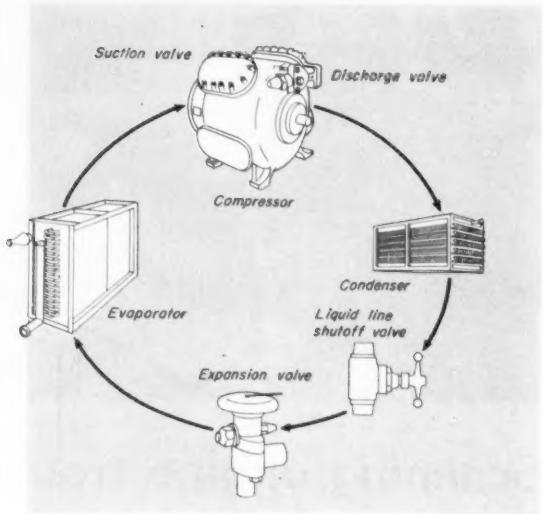
Power contact or agreement with the utility is far from routine and, in the opinion of E J McClure of Bethlehem Steel, speaking before the AIEE, it can and does pose a problem. Their contract at Bethlehem calls for the character of service to be continuous with a maximum 15-minute integrated demand of 60,000 kw allowed during any one month. At present this demand feature is not a problem even though their demand sometimes runs to about 79,000 kw.

Years past saw Bethlehem forced to play closer attention to their purchased demand to avoid exceeding the 60,000-kw limit. It meant, at times, shutting down one or more mills for a specified time until the particular 15-min demand period passed. And that can be ticklish business, especially with a large piece of steel in the mill. Pressure in this area has been lightened because of relatively large present capacity of the utility's 25-cycle system. The future, however, may see a change because of continuing pressure by the utility to convert to 60 cycle.

Weekends are problem periods today. Bethlehem has an excess of generating capacity while the utility won't take backfeed. So excess blast-furnace fuel is discharged into the air.

Final of a 3-part guide developed by the Trane Co

Refrigeration not running right?—trouble could be electrical



Trouble	Probable Cause	Symptoms	Recommended Action
M. Compressor will not start —hums, but cuts out on starter overload	1. Improperly wired	1. Compressor will not run—hums	1. Check wiring against wiring diagram
	2. Low line voltage	2. Same as above	2. Check mainline voltage—determine location of voltage drop
	3. Open starting capacitor	3. Same as above	3. Replace starting capacitor
	4. Relay contacts not closing	4. Same as above	4. Check by operating manually. Replace inoperative relay
	5. Open circuit in starting winding	5. Same as above	5. Check wires to stator. If wires OK, replace motor
	6. Stator winding grounded	6. Same as above	6. Check wiring to motor. If wiring OK, replace motor
	7. High discharge pressure	7. Same as above	7. Eliminate cause of high discharge pressure. Make sure compressor discharge shut-off valve is open. See G (Part 2)
	8. Tight compressor	8. Same as above	8. Check oil level. Repair compressor if damaged
N. Compressor starts, but motor will not get off starting winding	1. Low line voltage	1. Motor runs continuously on starting winding	1. Measure line voltage. Contact power company to correct voltage
	2. Improper wiring	2. Same as above	2. Check wiring against wiring diagram
	3. Defective relay	3. Same as above	3. Check operation manually, replace relay if inoperative
	4. Running capacitor shorted	4. Same as above	4. Check running capacitor
	5. Starting and running windings shorted	5. Same as above	5. Check resistances. Replace motor if burned out
	6. Starting capacitor open	6. Same as above	6. Replace starting capacitor
	7. High discharge pressure	7. Same as above	7. See G (Part 2) and M-7
	8. Tight compressor	8. Same as above	8. See M-8

Trouble	Probable Cause	Symptoms	Recommended Action
O. Compressor starts and runs but cuts out on overload	1. Low line voltage	1. Compressor cuts out on starter overloads	1. Measure line voltage. Contact power company to correct voltage
	2. Additional current passing through starter overloads	2. Same as above	2. Check for incorrect wiring—fan motors, pumps, etc, connected to wrong side of starter overloads
	3. Suction pressure high	3. Same as above	3. See J (Part 2)
	4. Discharge pressure high	4. Same as above	4. See G (Part 2) and M-7
	5. Starter overload heaters damaged or incorrect size	5. Same as above	5. Check current—replace starter overloads if damaged or wrong size
	6. Running capacitor inoperative	6. Same as above	6. Check capacitor. Replace if inoperative
	7. Stator partly shorted or grounded	7. Same as above	7. Check resistance, check for ground. Replace motor if necessary
	8. Compressor tight	8. Same as above	8. See M-8
	9. Unbalanced line voltage (3 phase)	9. Same as above	9. Check voltage of each phase. If not equal, contact power company to correct condition of unbalance
P. Starting capacitors burn out	1. Rapid cycling of compressor	1. Repeated failure of starting capacitors	1. Replace starting capacitor. Correct rapid cycle condition. Check thermostat circuit for faulty thermostat or bad connections
	2. Prolonged operation on starting winding	2. Same as above	2. Check for low line voltage. Contact power company to correct voltage
	3. Relay contacts sticking	3. Same as above	3. Clean contacts or replace relay
	4. Improper capacitor	4. Same as above	4. Check for proper capacitor rating
Q. Running capacitors burn out	1. Excessive line voltage	1. Repeated failure of starting capacitors	1. Reduce line voltage so as not more than 10% under rated voltage of motor
	2. High line voltage and light load	2. Same as above	2. Reduce line voltage so as not less than 10% over rated voltage of motor
R. Relays burn out	1. Low line voltage	1. Repeated failure of relay	1. Increase voltage so as not less than 10% over rated voltage of motor
	2. Excessive line voltage	2. Same as above	2. Reduce voltage so as not more than 10% over rated voltage of motor
	3. Incorrect running capacitor	3. Same as above	3. Replace running capacitor with correct capacitance and voltage
	4. Rapid cycling of compressor	4. Same as above	4. See P-1
	5. Relay vibrating	5. Same as above	5. Secure relay on mounting
	6. Incorrect relay	6. Same as above	6. Replace with correct relay

By A P OSTI, Safety Engineer
Pfizer Chemical Company

PERMIT is required for adaptor used when nonexplosionproof equipment is used in hazardous area. Supervisor of area inspects for explosive gas before the permit is granted

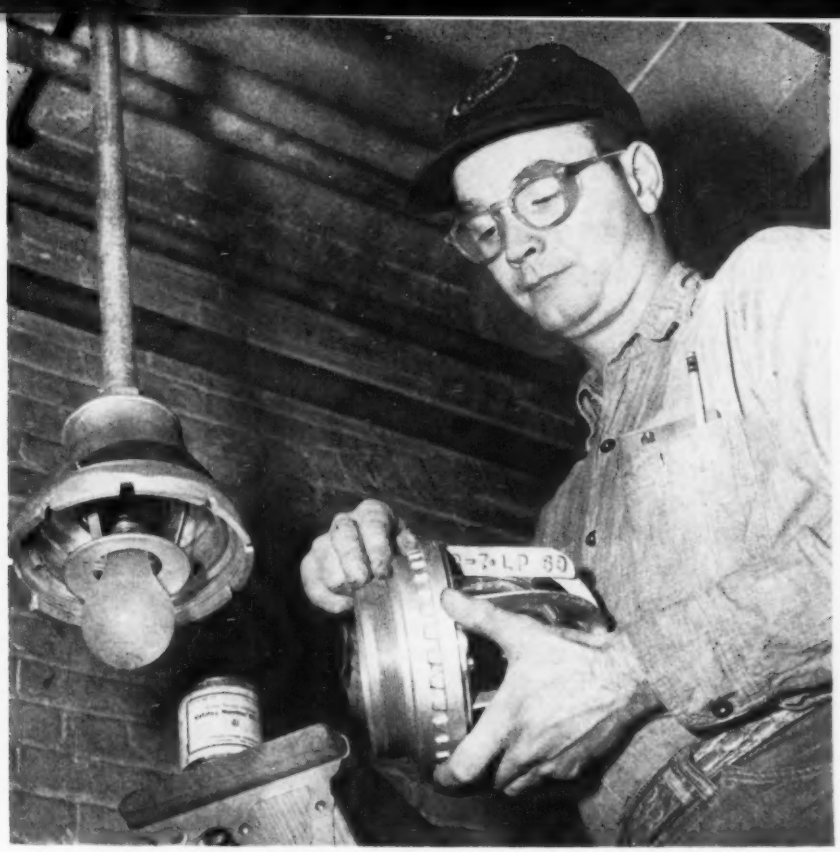
How we maintain electrical safety in

Safety engineers in plants where processes are likely to produce explosive gases or vapors are always concerned because a spark may originate in electrical equipment and ignite the atmosphere. It's not too difficult to make original installation safe; adequate equipment and methods are available. Trick is to see that it's maintained safely. This is really two problems — maintaining safety during normal operation and maintaining safety during repairs or other unusual conditions. Here are some rules and procedures which we have found effective in our big Brooklyn plant. (See POWER, Feb 1953, p 107 for a story on general electrical maintenance at Pfizer.)

In normal operation, hazardous areas are inspected at regular intervals by the area supervisor to make sure that all motors, wiring, switches, etc are meeting safety requirements. Explosionproof enclosures must be used for all electrical equipment, and must be properly sealed. The inspector keeps his eyes open to see that no equipment is introduced that is not classified for the particular type of hazard in the area. When questions arise the area supervisor requests the electrical department to come in and make a complete check for that department.

There's an electrician in charge of each of several designated plant areas. Operators or nonelectrical maintenance men are not allowed to open any electrical enclosure to replace a fuse or for any other reason, but must call an electrician. If necessary, machine remains out of service until electrician arrives, which is usually not very long.

Electrical safety education is part of extensive general safety education program, which concentrates on one aspect of safety each month. (POWER, April 1954, pp 86-89). When electricity's month comes around, posters and pay-envelope inserts alert personnel. The regularly scheduled "foremen's talks" have an electrical-safety theme. Typical subjects are grounding, due respect for low voltage, etc. During one "electrical month" a film was shown in the cafeteria. It ran for ten minutes and was repeated throughout the hour between noon and one pm. Outside organizations are occasionally brought in to give lectures and demonstrations on some aspect of safety. Recently a leading manufacturer of explosionproof enclosures and fittings gave a lecture in the plant on how to select and apply explosionproof equipment (this company, like



SERIAL NUMBER on every explosionproof fixture keys it to wiring diagram, helps assure correct procedure. Only electrician, shown greasing threads, may replace light bulbs

RED DOT is painted on fitting by electrician to show enclosure has been sealed

hazardous areas

many others, had a well-trained staff for the purpose of on-the-job demonstrations.)

Electrical foremen keep in touch with men in the plant. They are thus aware of typical problems and can help the engineering department find ways to reduce or eliminate recurrence of particular problems.

Extension cords are frequently subjected to rough treatment, and insulation abrasions or damaged connectors can burn open in use, creating the carefully avoided spark. For this reason only explosionproof extension cords are used, and these are very thoroughly inspected. Adequate lighting is provided to minimize use of extension cords during machine setup or nonelectrical repairs.

For repairs or maintenance, a permit must be obtained before any explosionproof housing, such as one for a switch or controller, can be opened or any nonexplosionproof tools or equipment brought into hazardous areas. The permit is given only after supervisor in charge of the area has completed tests and found no explosive gases or vapors present.

Special attention is given to explosionproof lighting fixtures. Each has a permanent brass circuit tag which identifies the proper circuit. The electrician can then switch off the circuit before opening the fixture. Also, by knowing what other lamps are supplied by the circuit, he can decide whether it is advisable to shut down to make the repair or wait for a more convenient time.

Upon completion of an explosionproof installation all seals are painted with a red dot to indicate that they have been properly sealed.

EXTENSION CORDS get thorough inspection for defects which might cause sparking

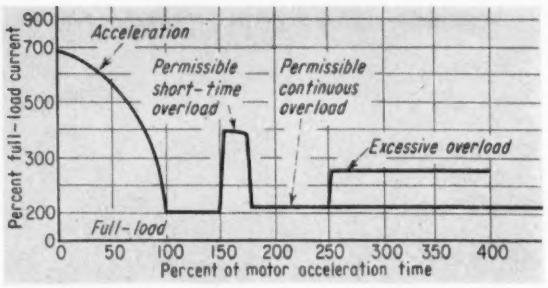
Plant Electrical Fact File

NO. 22: OVERLOAD PROTECTION

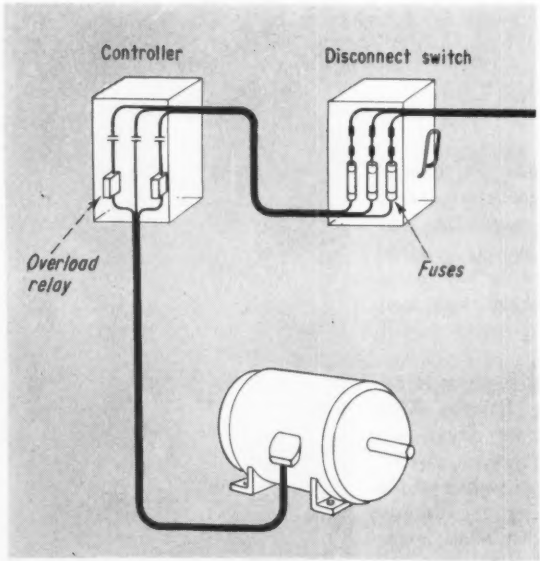
4 methods of ac motor overload protection

By NORMAN PEACH, Assistant Editor

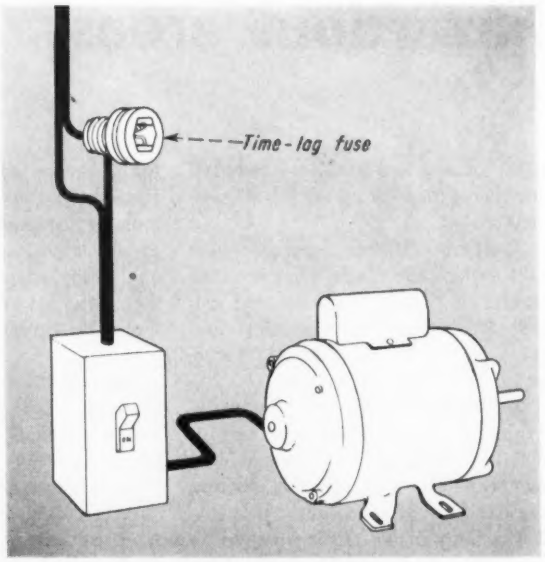
Motor-current conditions



INVERSE-TIME characteristic is essential in motor overload protector. Relay must not trip during accelerating period, or short overloads, but must trip quickly on stalling overloads. On long-time overloads, relay must be able to disconnect motor before coils are damaged.

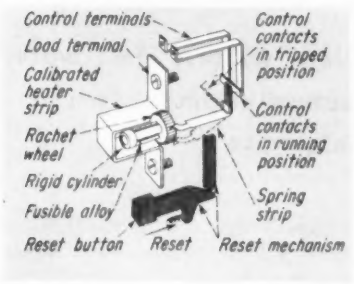


1 MOTOR STARTER with built in overload protection is most popular arrangement for across-the-line starting. Today's starters mostly use thermal relays, especially fusible-alloy type. Relays are ordinarily only in two of phase wires. Short-circuit protection is supplied by separate fused switch or circuit breaker. Reduced-voltage starters usually have overload relays for similar hookup.

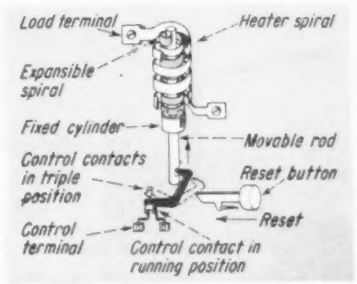


2 TIME LAG FUSES can sometimes be used to advantage. Fuse provides both overload and short-circuit protection. Especially popular for fractional hp motors, lag fuses are also available in cartridge form for integral hp motors. Fuses must be installed in each ungrounded wire supplying motor. Plug fuses have special bases so different ratings can't be interchanged, reducing protection.

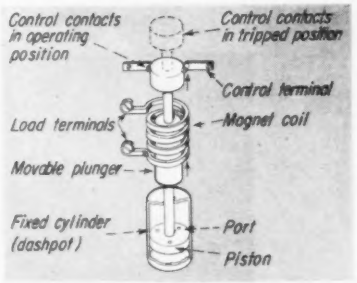
Typical overcurrent relays



FUSIBLE-ALLOY melts at predetermined temperature; ratchet wheel is turned by spring tension, releasing the ratchet. Contacts then open up.

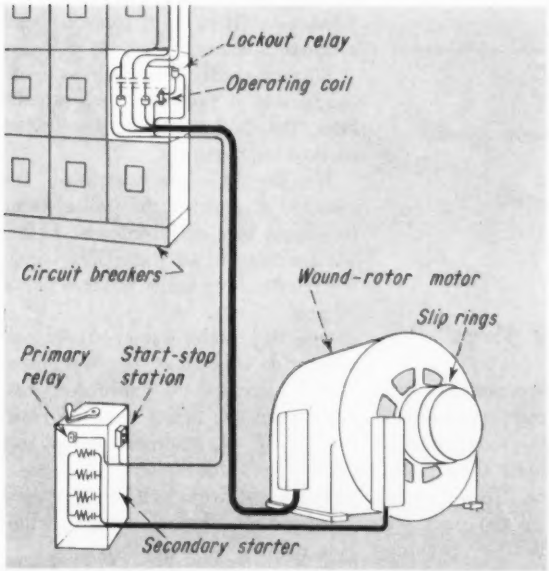


BIMETAL inner spiral expands in proportion to heat, causes rod to move up, tripping contact linkage. When rod drops, relay can be reset.

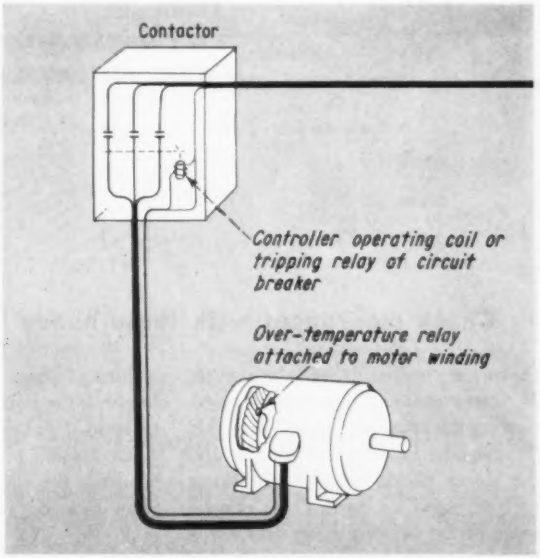


MAGNETIC attraction of the plunger is proportional to current in coil. Dashpot provides inverse time. Air or oil squeezes past rising piston.

Motors in almost any application need overload protection. Instantaneous circuit interrupting devices, such as typical fuse, won't do the job. Current sensing device, like three below and induction-type, not shown, must incorporate time-lag. Overload damage to ac motors comes mainly from overheating; time overload can be sustained varies inversely with current.

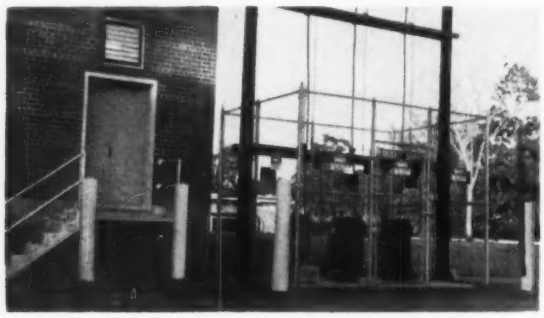


3 **CIRCUIT BREAKER** can provide overload protection with some arrangements. Wound-rotor motor shown employs secondary-resistance starting. Remotely operated circuit breaker serves as primary control. Circuit breaker includes relay which prevents closing unless secondary controller is in starting position at which time maximum resistance is in the circuit of the rotor.


Contactor
Controller operating coil or tripping relay of circuit breaker
Over-temperature relay attached to motor winding

4 **OVERTEMPERATURE** relay imbedded in motor windings, or attached to stator or rotor core, is sometimes more satisfactory than separate overcurrent relay. For motors which are started frequently, or have long accelerating periods, this method is advisable. Disadvantage is inaccessibility for repair. More than one relay can be used to monitor heating in different parts of motor.

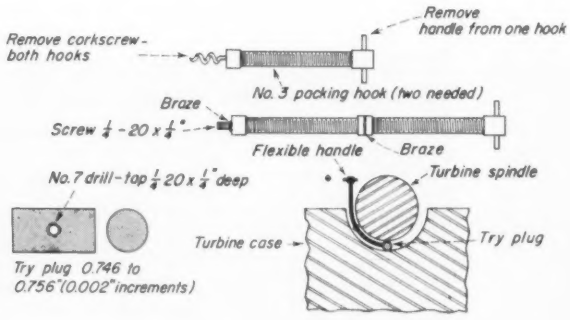
Timely **practical ideas** to help solve



Steel posts guard transformers

Concrete-filled 8-in. pipes make rugged guards to ward off trucks and other vehicles. They protect unloading platform and transformer substation at our plant, photo. Pipes are about 5 ft 6 in. above ground, 3 ft 6 in. below ground, set in concrete. If you have old piping on scrap heap, just fill with concrete. There's no need to use new piping. Paint with aluminum so posts are easily visible.

J MORGAN, *Holbrook, Mass.*


Remove handle from one hook
Remove corkscrew - both hooks
No. 3 packing hook (two needed)
Braze
Screw ¼ - 20 x ¼"
Flexible handle
Braze
No. 7 drill - tap ¼ 20 x ¼" deep
Turbine spindle
Turbine case
Try plug
Try plug 0.746 to 0.756" (0.002" increments)

Check clearances with these handy "try plugs"

On turbine overhauls we take a series of "rotor position" checks before removing the spindles. These show that the relation between the spindle and the steam packing fits in the lower half of case. To do this, we remove some of the packing rings and check the clearance between packing fit and spindle by using "try plugs." Plugs are about 1½-in. long and of various diameters. By trying different sized plugs, we can check the clearance on each side of the spindle, also the bottom clearance. Plugs are drilled, tapped ¼-20 for inserting handle.

Idea of plugs is not a new one, but to check the bottom clearance we had to bend a rod for each size packing. Then we slid plug under the spindle to check the clearance. To get away from bending rods all the time, we took two No. 3 flexible packing hooks, removed the corkscrews from both hooks and the handle from one. We brazed them together, and brazed a ¼-20 screw on one end. Screw is inserted in plug. Handle is flexible enough to slide the plug under spindle, regardless of packing size.

H C BOSLEY, *Long Beach, Calif.*

Now, we test rinse water before putting softener in service

I took charge of a hospital steam plant whose boilers were badly choked with scale. No internal treatment was used and external treatment was from two sodium-zeolite softeners. But their workable life had long since expired. Makeup was about 75%; hardness was 18 gpg. Insurance inspector insisted that boilers be cleaned if they were to run the next season.

I first started treating boiler internally. This was done gradually so scale wouldn't be loosened or dissolved too rapidly and cause operating troubles. Then we installed two 3x8-ft softeners with multiport valves and a 4x5-ft brine tank. We could dump a ton of salt into this size brine tank and thus save valuable storage space. Each softener was filled with 22 cu ft of resinous-bead synthetic zeolite.

We next started to reclaim as much condensate as possible. Two months later the boilers were showing a marked improvement.

We kept a close watch on the chloride content of the boiler water to govern rate of blowdown. Chloride reading of raw water was 7 gpg. We tried to keep boiler water at about 12 gpg.

One day boiler-water sample had a chloride reading of 18. We immediately increased the blowdown. Following day we had a chloride reading of 32. I suspected brine was getting into the system, so I sampled effluent from softener that had just been regenerated. It had a chloride reading of over 30 gpg.

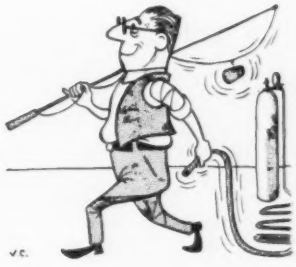
Checking log sheet, I found that softener had been regenerated by a new operator. He had been instructed to rinse the softener until rinse water no longer tasted salty. Evidently he didn't have as sharp a taste for salt as we did. A 10-minute longer rinse brought chloride reading down to

eight, which was close to raw water.

Experimenting, we found that none of us could detect a salt taste in the rinse water when chloride reading was in thirties. This indicated we were certainly blowing down our water excessively. After that, a chloride test of rinse water was made before softener was put in service. This has become a fundamental part of our operating routine. We cut our blowdown by 75%.

Manually or automatically operated, I believe softeners require the engineer's utmost attention if he wishes to maintain close control on his feedwater and boiler water.

R J ANDERSON, *Winona, Minn.*

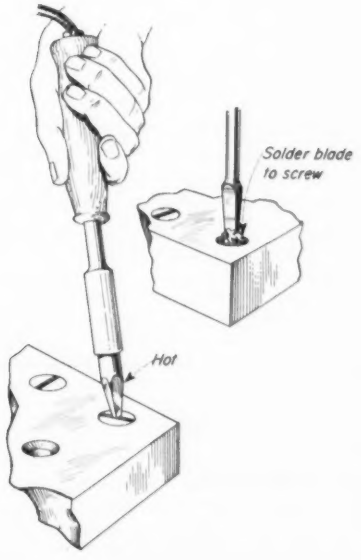


What would you have done?

While inspecting a boiler after an acid cleaning, a putty knife was dropped into a 3-in. 30-ft long downcomer tube. Tube had two long 30-deg bends and two short 90-deg bends. Knife lodged at one of the 90-deg bends. An electrician's tape, a plumber's snake, an air hose and a water hose were used in an attempt to dislodge the knife, but without success.

So we blew a rubber cork tied to a fishline through the tube. Air hose was held about three inches from top of tube so cork and line could be fed in easily. When air was turned on, cork line and putty knife all came out the bottom. Jet effect of compressed air had created enough volume of air to force putty knife around the bends. What would *you* have done?

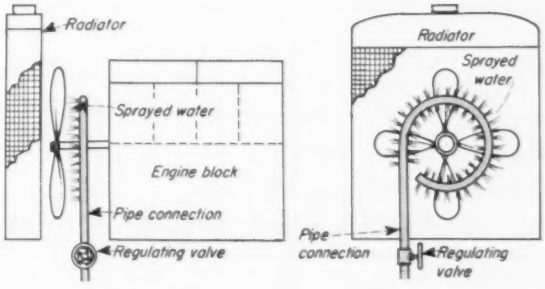
J BARNES, *Grifton, N. C.*



Heat will loosen that screw

To loosen stubborn screws that won't start on the first try, don't ruin the slot with a slipping screwdriver. Try the stunt shown in sketch. Apply heat to head with an electric solder iron. This will loosen the screw. If not, you can then solder a screwdriver into the slot. You can remove the solder afterwards.

C H WILLEY, *Penacook, N. H.*



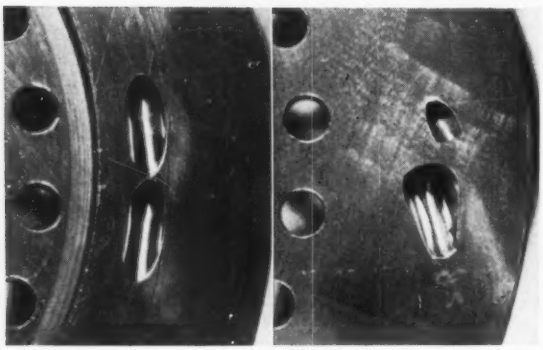
Spray cools radiator temporarily

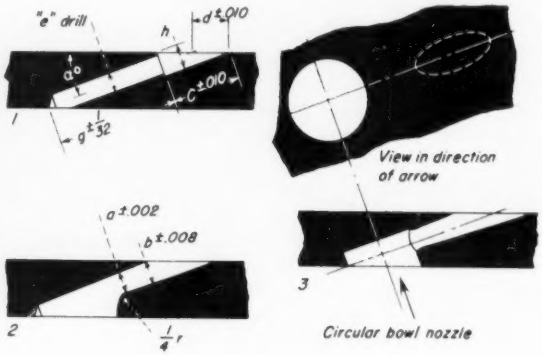
Our tractors have been operating for almost nine years without changing the radiators. We made some minor leakage repairs, but only partial cleaning could be done because we need to keep the machines running.

I noticed that evaporation was coming out from top of radiators at times. Thinking that the thermometer might be defective, I installed a temporary remedy, sketch. A bent 3/8-in. pipe, with 1/16-in. perforations set 1/2 in. apart, was installed to cool the radiator with rain water during peak loads. That brought the temperature down to normal. I could have lowered the temperature still more if I had to.

A CAMACHO, *Cebu City, P. I.*

Turn page for more Practical Ideas ►





You should know the Brooks turbine nozzle

This nozzle and bowl isn't as well known to power engineers as the circular bowl nozzle. Tests show there's no difference in efficiency of the two nozzles, but Brooks nozzle is less expensive to make. Only 6 to 8 different taper reamers are needed to cover a large number of expansion ratios. The nozzle with circular bowl requires 3 to 4 times as many reamers. By changing reamer and length of nozzle, you can get the expansion ratio desired. If nozzle is too long for best efficiency, use a reamer with a steeper taper. If too short, use one with less taper.

Cheapest way to make bowl is by hand. Years ago an air hammer, chisel, file and a strip of emery cloth were used. But now small grinders save time. Nozzle inlet is finished to micrometer dimensions.

First photo shows the outlet of nozzles, second photo the inlet or bowl side of the same nozzles. Large hole has been bowled. Small hole has been reamed and is ready for bowling.

First sketch shows method of dimensioning for wrought machining, which is to end-mill. Next step is to drill for reamer. Fig. 3 shows the method of dimensioning for finished reaming and nozzle inlet size when bowling. Top of the bowl can be wider than reamer's diameter but never less. Bowl's edges should be rounded off. The 1/4-in. radius in nozzle's throat fades into nozzle's sides.

Use a nozzle sheet to furnish all dimensions for letters on drawing. Also give drawing number of reamer.

K MacDonald, *Wellsville, N. Y.*

Avoid left out parts by using check list on every job

Check list, right, is a good way to assure complete reassembly jobs and correct installation procedures. Whenever a piece of equipment is taken down, make a list of all parts being removed and all operations that must be performed. Check off each item as it's taken out and each operation as it's finished. Then make another mark when the part is returned. A glance at the list tells you immediately if anything has been forgotten during the installation procedure.

H B Wayne, *Woodhaven, N. Y.*

Disassembly			
Piece No.	Item	No. of Parts	Check
1	End Bell	1	X
2a	Outboard Bearing	1	X
2b	" "	1	X
2c	" "	1	X
2d	" "	1	X
3	Impeller	1	X
4a	Oil Rings	1	X
4b	" "	1	X

Assembly			
Piece No.	Item	No. of Parts	Check
1	End Bell	1	X
2a	Outboard Bearing	1	X
2b	" "	1	X
2c	" "	1	X
2d	" "	1	X
3	Impeller	1	X
4a	Oil Rings	1	
4b	" "	1	

Turn page for more Practical Ideas ▶

Hall Industrial Water Report

VOLUME 6 FEBRUARY 1958 NUMBER 1

By No Stretch of the Imagination

—can one think of getting along in the rubber industry without lots of water. And all the water used for generating steam, cooling, or general service must be conditioned to avoid problems such as deposit formation and corrosion. Undisciplined water can increase costs, hamper production and even shut down the plant. Contaminated waste water must also be cleaned up for disposal.

Hall Engineers are presently working with more than 80 plants in the rubber industry to avoid problems related to water. Whatever your industry, they can help you, too, with their special training and experience in the treatment of boiler water, cooling water, service water and process and waste water.

Careful Control Pays Off

In 1950 Hall staff engineer Len Highley set up the water conditioning procedures for two new boilers to provide steam at 550 psig in an eastern tire plant. Since then operation has been uneventful except for a short period of difficulty with hot-process softener filters and a temporary scare due to soap contamination of condensate. Because of these two events the boilers were acid washed as a precautionary measure early in 1956.

A recent report to Highley reads "We are sorry you were not able to get down to go over our No. 1 boiler, but we thought you would like to know that it was in the same clean condition as No. 2 which you inspected. Our operating people were very pleased and they have noted nothing to cause any concern or question."

This case might be considered just a routine report if we did not "look behind the scenes." There we find the close cooperation between the Hall engineer who prescribes water treating procedures on the basis of his study of the plant and the plant operating men who faithfully and carefully do the important job of maintaining day by day the water conditions which spell success.

Quick Diagnosis

When he collected a sample of the effluent from the hot lime-soda softener at a western tire plant, Hall Engineer John Henricks was surprised to find a noticeable amount of suspended matter in the water. This was unusual because, even though the softened water was not filtered, it had always been remarkably free from precipitated hardness which settled out in the sedimentation tank.

Investigation promptly disclosed that numerous new tire machines had boosted the load on the boilers and softener beyond rated capacities. The increased flow rate had to be maintained, but something had to be done to clean up the treated water to avoid increased chemical consumption in the boilers and abnormal sludge concentration in the boiler water.

Reasoning that a denser and deeper sludge blanket was needed in the softener tank to "filter" the suspended matter from the treated water, Henricks recommended reducing the blow-off from the tank and raising the level of the sludge blanket 6 to 12 inches. With these changes made, the softener water again was clear. But now there was another problem. The hardness of the water was running 0.5 gpg higher than normal. Henricks traced this to inaccurate weighing of treating chemicals and adjustment of slurry level in softener chemical tanks. With careful weighing of chemicals and preparation of slurry, hardness of the treated water ran consistently low at 0.2 to 0.3 gpg.

This is a case where the experience and training of the Hall Engineer enabled him quickly not only to spot trouble in the making but to diagnose the problems and solve them before they caused real trouble.

How to Fool a Deaerator

On his first service visit to a rubber reclaiming plant the Hall field engineer found an arrangement which topped all of his unusual experiences. Chemicals for the low-pressure boiler were fed continuously from two pressure pots with cold zeolite-treated water. The effluent from one pot entered the makeup water line to the deaerator downstream from the flow control valve. The effluent from the other entered the boiler feed line downstream from the deaerator.

Approximately 2000 gpd of water passed through each feeder. At low loads, when no makeup water was required, the cold water flowing into the deaerator from both feeders merely overflowed to the sewer. This also upset heater operation so when the load picked up undeaerated water was pumped to the boiler. The cold, undeaerated makeup water flowing into the boiler feed line continuously introduced dissolved oxygen into the boiler. Finally, at relatively low loads condensate entering the deaerating heater overflowed to the sewer.

By making a few simple piping changes so one feeder could be used intermittently to feed all chemicals, the Hall engineer was able to reduce makeup water consumption from 6000 gpd to 2000 gpd, to cut chemical feed by 75% and to insure satisfactory deaerator operation.

Industrial Water Problems Require Special Handling

There are no "stock answers" to industrial water problems. For information on how the Hall System can help you solve your particular water problems, write, wire or call address below.

Water is your industry's most important raw material. Use it wisely.

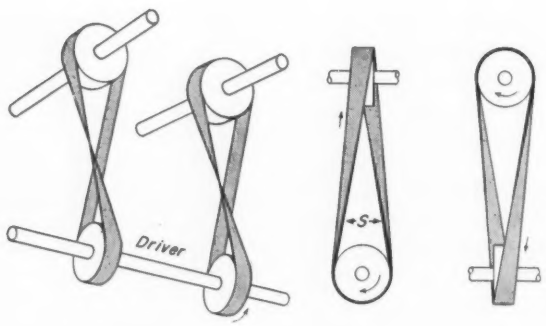
HALL LABORATORIES

DIVISION OF HAGAN CHEMICALS & CONTROLS, INC.
HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED - TORONTO

Hall Laboratories—Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

More **practical ideas**

Begins on page 128



Watch that quarter-turn belt drive

Flat-belting power transmission is still with us. In rare cases we must resort to the mongrel type of drive, the quarter-turn. Trouble with that maze of leather is one side stretches more than the other. Then, in time, the belt runs crooked, develops lots of trouble. In spite of well crowned pulleys, the belt tends to occupy only one-half of the pulley face and eventually slips off.

Where distances between centers are wide, trouble can be corrected by giving the belt a twist of 180 deg before splicing it by lacing or cementing. Half twist forces it to run true because it changes sides with every other revolution. Therefore, both sides are subjected to equal tension and the belt stretch is kept uniform.

To work right, this drive must have the opposing pulleys closer than five times the diameter of the large pulley. Any close centers will cause excessive wear by flexing and rubbing. We get best results if belt stock is ordered about 10% wider than the stock for plain open drives. Added width compensates for stretch to a degree and keeps the drive delivering almost rated horsepower.

Best results are obtained by using pulley on vertical shaft as the driver, (where one shaft must be vertical) as it causes belt's tight side to run onto pulley, (horizontal plane). Bugaboo of this drive is the inevitable slack, especially where pulley on horizontal shaft is driver.

Keep the belt as tight as possible and use the vertical pulley as the driver. If the vertical pulley is driven and the belt slips, build up the pulley crown with adhesive tape to compensate for some of the slack. Eventually slack must be cut out. This isn't hard to do if you make splice with laces of metal clips.

P C ZIEMKE, *Clinton, Tenn.*

Here's my answer . . .

In POWER, Oct 1957, p 129, C Bachmann told about charging oil into a Freon system without an oil pump. Mr Bachmann's idea was good in that it solved the problem. But, here's another way to add oil without an oil pump:

(1) Install a charging hose, pipe or tubing to the oil charging valve connection. (2) Pour oil into a clean open container. Open valve on charging connection to purge air. Just before valve is closed, immerse charging line in oil container. (3) Close suction shutoff valve, start and run compressor until a slight vacuum is reached. Open the oil charging valve. When enough oil has been added, as shown by sight glass, close the charging valve and open the suction shutoff valve to complete the job.

J E DUNN, *Bronx, N. Y.*

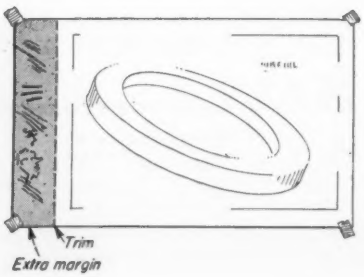
. . . and here's mine

Here's the solution to C Bachmann's problem. We have the headache of adding oil to our 100-ton ammonia compressor. It has a hose hooked to the oil-filling connection. By running the compressor with suction valve closed, vacuum builds up and oil is sucked into the crankcase. Of course, we take care not to get too much oil or air into the system. As long as machine has some oil in crankcase, this procedure is safe.

H E GRASECK, *Brentwood, N. Y.*

Did you know . . .

that *Plant Operators' Notebook*, McGraw-Hill Book Co has over 1500 illustrations to help you?



Save scratch paper

Instead of using a loose sheet of scrap paper for testing line widths, leave an extra inch margin on the edge of your drawing paper, sketch. Cut off the strip when you finish. You'll find that this is a simple solution to a sometimes messy problem.

N KHO-RAFANAN, *Cebu City, P. I.*

My biggest boner

Please turn to page 190

"our Yarway Impulse Traps give good performance, free from worry"

Q. Mr. Terrill*, you have more than 100 Yarway Impulse Steam Traps on almost every press in this Boonton Molding Co. plant. Why do you use Yarway?

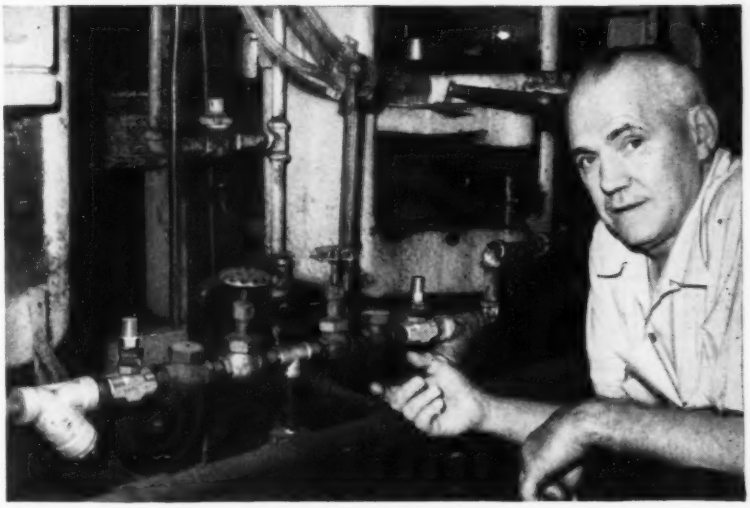
A. Because we never have to worry about them. They give good performance on our presses 24-hours a day and never cause any trouble.

Q. How long have you been using Yarways?

A. We started 5 years ago. Now we're almost 100%. There are only a few other type traps left. They'll soon be replaced by Yarways.

Q. These presses are pretty hot. At what temperatures do you mold?

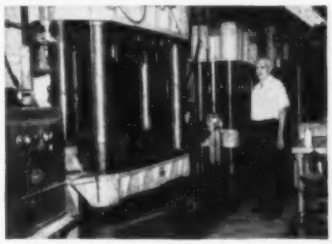
A. About 350°F. That's another advantage of Yarways. They *keep* the presses at high molding temperatures.



"Our presses are individually trapped with Yarways—over 100 of them in the plant"

Q. Any other advantages?

A. Sure. Small size, small inventory of parts, and they're easy to order from our distributors.

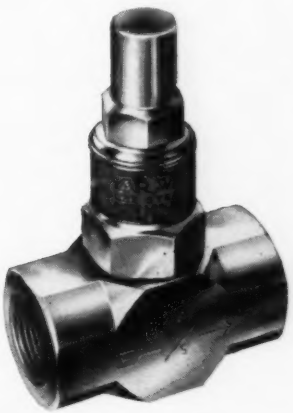


"Yarways never cause us any trouble"

For free copy of new booklet, "The Why and How of Steam Trapping," write:

YARNALL-WARING COMPANY
100 Mermaid Avenue
Philadelphia 18, Pa.

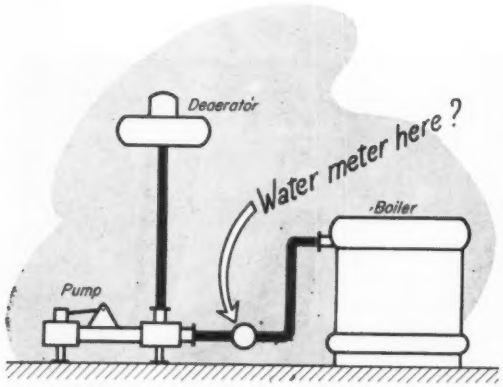
*STANLEY TERRILL,
Plant Engineer, Boonton Molding Co., Boonton, New Jersey



YARWAY impulse ...a good way to specify steam traps

OVER 1,200,000 YARWAY IMPULSE STEAM TRAPS ALREADY USED • STOCKED AND SOLD BY 275 CONVENIENT LOCAL INDUSTRIAL DISTRIBUTORS • NATION-WIDE YARWAY ENGINEERING STAFF AT YOUR SERVICE.

These **plant problems** could well be yours...



The problem

Can we install a water meter in our boiler-feed line?

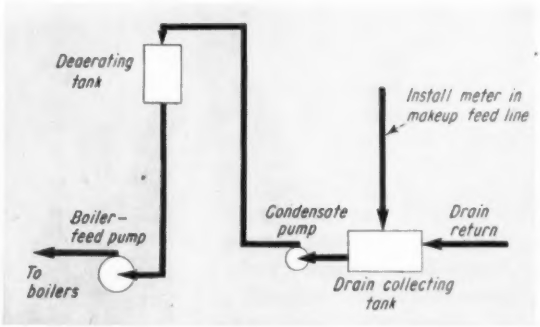
I'd like to know whether it is practical to install a water meter in our boiler-feed line under the following conditions:

The feed pump is a horizontal reciprocating duplex. Suction is 5 in. diameter and is connected to a deaerating heater. Head pressure on suction side is 20 ft, plus 5 psig in the deaerator. Discharge line is 2 in. diameter, 100 to 130 psig, water temperature is 230 F. Normal flow rate is 20 gpm but it can vary from 3 to 50 gpm. And under free flow it is possible, during short periods of blowdown, for flow rate to reach 100 gpm.

It's also possible, under abnormal conditions, for this pump to run dry or become steam bound and cause a heavy water hammer. The pump feeds three 100-psig water-tube boilers, each of 1500-sq ft heating surface.

I've never heard of water meters being used under such conditions and would like to know if it is a practical method of measuring water use.—*HCG, Nov 1957,* POWER

The solutions



Meter should be in makeup line

The use of a water meter in the feed line is an impractical way to determine the amount of water used. Once *HCG* lights the boilers off and puts them on the line, a certain percentage of the steam is returned as condensate. If meter is installed in the feed line, *HCG* would be counting a certain amount of his water over and over again.

Manufacturer's literature tells how much water the boilers hold at steaming level. *HCG* knows how much water the deaerator holds. On this basis, once the plant is started, he already knows how much water is in the system. He then needs to find out how much water is added in any given period.

HCG doesn't say whether or not his drains go to a collecting tank or directly to the deaerator. Assuming the drains go to a collecting tank, the meter should be installed in the makeup feed line, drawing above.

If, during the poor operating conditions mentioned, *HCG* could take on makeup feed rapidly enough, his feed pump would not lose suction or become vapor bound. A gage glass mounted on the deaerator would be of considerable help in forestalling this trouble.

M E DENTLER, *Portland, Ore.*

Could be done, but it's not practical

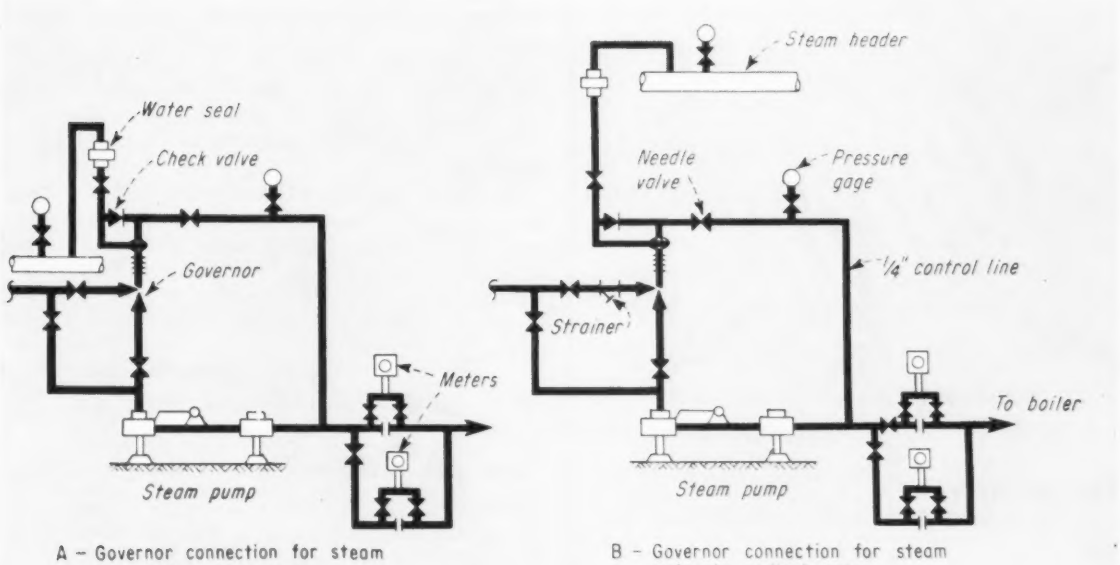
Meter manufacturers could probably build a meter to work under the conditions stated. But would it be worth it? Probably not. *HCG's* best bet is to stick to standard methods of measuring amount of water used.

For best results he should install a standard water meter on the cold water makeup line; a steam flowmeter on the boiler steam outlet, and meters on the continuous and intermittent blowdowns.

L E POLIKOFF, *Bethpage, N. Y.*

...Here's how *Power* readers would tackle them

ROBERT MARKS, Assistant Editor



A – Governor connection for steam main below diaphragm

B – Governor connection for steam main above diaphragm

Wide range of flow rates requires a special metering setup

The great differences in flow rates, ranging between 3 and 100 gpm, calls for a special metering arrangement. Two meters operating in parallel, drawing above, would do the job. The large-capacity unit meters high flow rates; smaller range instrument handles low flows.

The sketch shows a feedwater flowmeter installation following the steam pump. "A" is recommended when steam header is below the pump governor diaphragm; "B" is hookup where header is above diaphragm.

Parallel metering will provide accurate data throughout the range of flow conditions.

H B WAYNE, *Woodhaven, N. Y.*

How about one meter per boiler?

Apparently *HCG's* boiler plant has no steam flow or condensate meters. Thus he is planning to install a boiler-feedwater meter. If the insurance company doesn't object, *HCG* can go ahead and install the correct meter in the boiler-feed line. But it's not the best arrangement.

I would, as I have often done, install one meter per boiler. In this way individual evaporation figures are known. Such information can pinpoint many boiler plant ailments.

Of course, if *HCG* wants to, he could use the presently operating reciprocating duplex boiler-feed pump to determine the quantity of feedwater delivered. But this technique has many shortcomings.

C BACHMANN, *Jamaica, N. Y.*

Here's data on similar plant

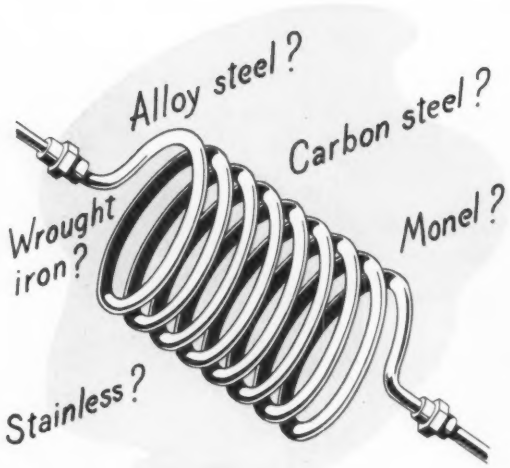
Having conditions similar to *HCG's* at our plant, I can offer some advice. Our installation has given us excellent service.

The feed pump is a horizontal suction (5-in.) taken from the deaerating heater. Vertical drop to pump is 8 ft. Discharge line (3-in.) delivers water at 212 to 224 F, 275 to 300 psig. Normal flow, 40 gpm, may vary from 3 to 100 gpm if required.

Dip in the flow recorder chart indicates pump running dry. Sharp peak in the chart shows blowdown. These jogs in the curve would also tell *HCG* when trouble or normal variations took place.

R HUNTER, *Alberta, Canada*

For info on steam coil corrosion, turn page ►



The problem

What's the best material to use for steam coils?

We are replacing steam coils for a customer who has had poor service from coils made of plain steel tubing.

Steam conditions are 600 psig, 600 F. Service is intermittent; on a few hours, then cold. We doubt if they really drain the system dry.

On the high side of the valves, fittings and pipe are, of course, steel. But on the low, wet side, parts are bronze or brass. This leads us to suspect the possibility of galvanic action. The outside surface of the coil is subject to oxidation, but only moderately.

We're considering making the new coils out of monel since it would probably have the best resistance to galvanic corrosion and has good properties in other respects. But how would it stand up under the temperature and pressure? And how thin a wall do you think we could get by with? Diameter is ¾ in.; coil about 200 linear ft. It's not a big job, but one we'd like to do right.—*GR, Nov 1957,* POWER

The solutions

Stainless steel will do the job

GR should switch to 18-8 stainless-steel tubing and his troubles will be at an end. For a small flash generator stainless-steel tubing is noncorrosive and has a high heat resistance.

I've tried 18-8 in a modified "White Steamer," a 12-coil generator with ⅝-in. OD tubing, extended length just over 200 ft. I've also used brass water pipe and fittings on the feed-pump side and stainless steel on the steam side.

We haven't experienced any galvanic action, pitting or warping of the steel coils. Automatic thermostat controls heat in a 600- to 750-F range. Within these limits we can select and set desired steam temperature.

Backed up by over 50 years of experience with small high-pressure steam-coil generators, we do not approve of the monel metal under the conditions *GR* mentions.

J HEYSER, *Los Angeles, Calif.*

Low pH, dissolved gases the trouble?

Corrosion described by *GR* could well be caused by low pH and/or dissolved gases in the condensed steam. Oxygen, carbon dioxide would be released by the reduction in pressure and temperature.

Stainless steel, type 310 or 316, should do a very good job and be much cheaper than monel. Wall thickness of .025 inches should be adequate provided there is no severe shock. *GR* should contact his local tubing distributor who can make reliable recommendations.

J H WOODWARD, *Superintendent*
Cecil Lynch Station, Little Rock, Ark.

How about using wrought iron?

GR's best bet for the piping is wrought iron. He can get it in various thicknesses and special properties, depending on its application: coiling, bending, flanging, etc.

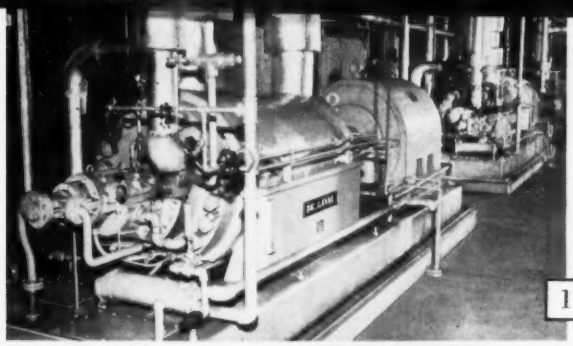
Wrought iron is highly corrosion resistant. Some of today's wrought-iron pipe installations date back 50 years under corrosive conditions.

For more detailed info on specifications of wrought iron pipe, consult American Society of Testing Materials *Spec A72.*

For the pressures and temperatures *GR* mentions, cast- or forged-steel valves should be used. Bronze or brass valves are definitely not recommended for this service. They generally are not suited for temperatures over 550 F. In fact many codes prohibit the use of bronze or brass valves for conditions over 450 to 500 F.

L E POLIKOFF, *Bethpage, N. Y.*

For more on coil corrosion and new problems, turn page ▶



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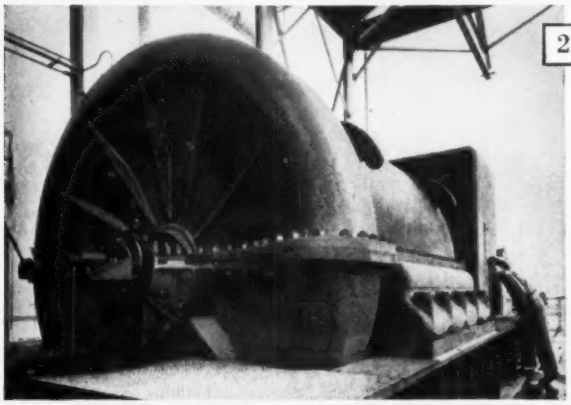

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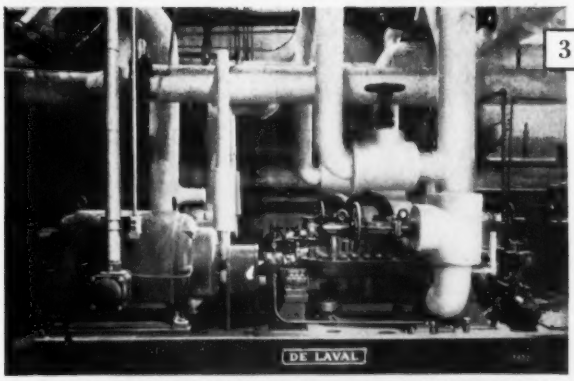

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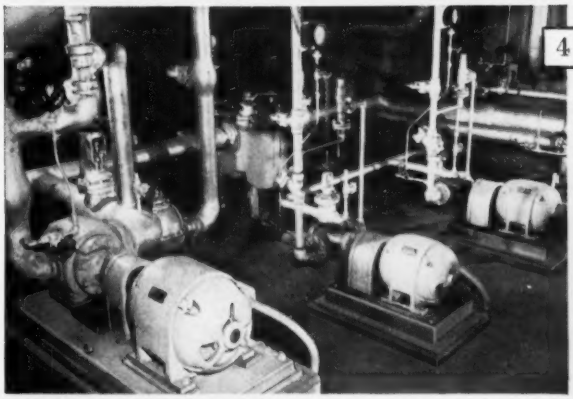

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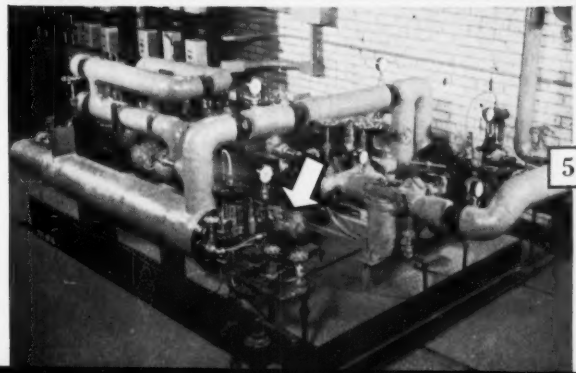


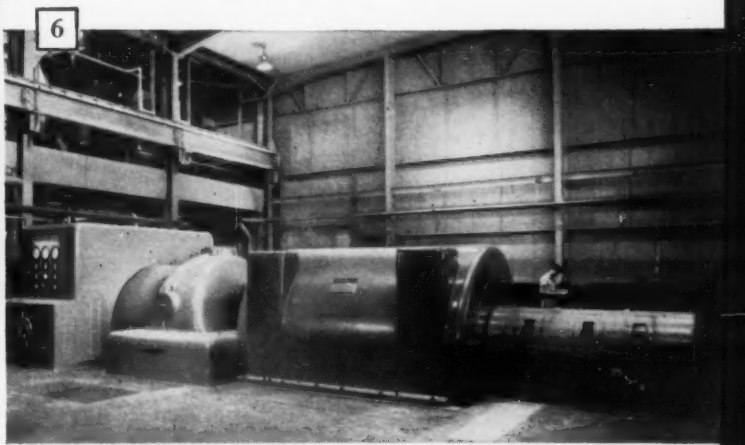
5

DE LAVAL

designs for dependability

Machines that *stay* in service year in and year out are the most economical. Since 1901, De Laval has supplied quality-designed pumps, compressors, and other vital equipment for industry. Each unit is designed for dependability and built by master craftsmen. As a result, the De Laval name plate is your assurance of reliability. Literature is available on all equipment shown on these pages.

1. Barrel type boiler feed pumps
2. Centrifugal compressors
3. Centrifugal pumps for many services
4. De Laval IMO pumps for fuel oil transfer
5. De Laval IMO pumps for fuel oil burner service
6. Multi-stage turbine generators



6

DE LAVAL

Steam Turbine Company

815 Nottingham Way, Trenton 2, New Jersey

DL-461

Begins on page 134

Galvanic series

Anodic, corroded end	Muntz metal
	Brasses
	Copper
Magnesium	Bronzes
Magnesium alloys	Copper-Nickel alloys (Monel)
Zinc	
	Nickel
	Inconel
Aluminum	
Cadmium	Stainless steels (passive)
	Hastelloy C
Mild steels	
Alloy steels	Titanium
Wrought iron	
Cast iron	
	Silver
Stainless steels (active)	
	Graphite
	Gold
Ni-Resist	Platinum
Soft solders	**Cathodic, protected end**
Lead	
Tin	

Metals near the top of this series act as anodes, suffer corrosion when coupled with one near the bottom. Galvanic couples of metals close together in this series usually corrode more slowly than couples composed of metals from the extremes. Couples of metals within each grouping have the least tendency to corrode.

GR should look at galvanic series

When any two of the metals in the table, above, are coupled together, a galvanic potential is set up. Resulting effect, if potential is sufficient, is galvanic corrosion. Hydrogen gas is arbitrarily taken at zero potential. Metals in the lefthand column of the table are increasingly active; metals in the righthand column are increasingly inert.

For the environment described by *GR*, the galvanic potential between steel and brass or bronze is not great enough to cause serious corrosion. Comfort heating systems are examples of piping systems employing steel, brass and bronze materials. These assemblies have nonferrous valves, strainers and traps screwed to steel pipe and passing wet steam and condensate. They have a history of trouble-free operation.

In a closed system having tight joints and provision for adequate venting, most of the air, oxygen and other insoluble gases are released during initial start-up. Little, if any, of these gases are present after this time.

GR mentions exterior corrosion. I suggest that he examine both the interior and exterior surfaces of the corroded tubing. External corrosion may result from high oxygen liberation during heating periods. This is particularly troublesome in open vessels having liquid surface exposed to the atmosphere.

Assuming that annealed monel tubing having a tensile strength of 70,000 to 80,000 psi is to be used, the allowable working stress (S value) is 17,500 psi (according to *ASME Piping Code* for 600 F). Required tube-wall thickness can be figured from:

$t = PD / 2S = (600)\ (0.75)\ /\ (2)\ (17{,}500) = 0.0129$ in. Permissible wall-thickness variation for ¾-in. tubing is 10%. Thus, the above figure should be increased to 0.0141 in.

H B Wayne, *Woodhaven, N. Y.*

Your February problems

Which temperature measuring elements should we use?

To keep closer tabs on operating conditions in our plant we're planning to add measuring instrumentation at a number of key points in our steam, condensate, fuel oil and cooling-water systems.

Our first thought was to use filled-system temperature bulb thermometers. But we're also considering possibility of bi-metal as well as industrial liquid-in-glass thermometers. In some cases we'll be indicating; in others, recording. Our top temperature is 750 F. We'd like to hear experiences of Power readers with temperature measuring instruments for the above applications.—*HCA*

What's best way to support steam piping in tunnels?

We're engineering the heating system for a large apartment-house development that will be heated from a central heating plant. Consisting of nine multistory buildings, the development will cover almost 30 acres.

We're planning to run steam heating pipes in tunnels, radiating out from the heating plant. Because of the extensive nature of this network, we are interested in any economies that can be made. For one thing, we wonder about supporting the steam lines on the exterior of the pipe insulation, to minimize heat given off, reduce line losses. This, we believe, will also simplify inspection and maintenance work in the tunnels. Have Power readers had experience with this type of installation?—*AHD*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches.

STOP FUEL WASTE

...YOU SAVE DOLLARS WHEN YOU INSTALL GENERAL CONTROLS DRAFT CONTROL SYSTEMS!

You stop fuel waste when you install the new General Controls E-5 Draft Control System. You save money with any type boiler... any type fuel!

Besides fuel savings up to 25%... automatic draft regulation helps you save manpower as well. Even in a one-man boiler room the savings can exceed a thousand dollars in one year! Another benefit: in addition to *money savings* you'll *increase good will by adequate smoke control.*

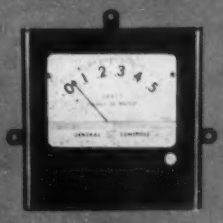
Ask the General Controls Factory Representative in your area to show you how draft regulation will benefit your installation. Call him in soon.

THIS IS THE GENERAL CONTROLS DRAFT REGULATION SYSTEM...

ADVANCED DESIGN E-5

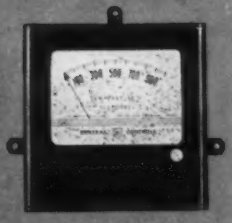
DRAFT-PROGRAM CONTROL...
Master unit programs damper action for start-up and shut-down, plus setting correct damper position for any firing rate. Optionally, it will provide Low Draft Cut-off, Time Delay Cut-off, Adjustable Starting Draft... it not only acts fast... it's accurate! It even senses changes in atmospheric conditions!

ACTUATOR...
Responding to the commands of the Draft-Program Control, this unit positions uptake damper. Maintains correct draft conditions continuously without attention.



DRAFT GAGE...
Instrument gives continuous visual reading of draft conditions. Operator always knows what is going on... no guesswork!

TEMPERATURE GAGE...
Flue gas pyrometer instrument shows efficiency of boiler... warns operator of wasteful firebox conditions!



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Burbank, California
Iron Mountain, Michigan
Skokie, Illinois
Guelph, Canada

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Factory Branch Offices Serving All Principal Cities of the United States and Canada

Your page for **comment** on the ever-changing power scene

BOB BELLAS, Assistant Editor

A good subject short circuited?

A H Knable's "Two ways to figure s-c current," POWER, Jan 1958, p 97, is very good in concept and presentation. However, I believe it has been oversimplified in the interest of brevity and at a sacrifice in accuracy of statement. For example:

(1) Percent X referred to throughout is % reactance, not % impedance as stated.

(2) There's not enough distinction between calculations for interrupting duty versus momentary duty on breakers. Example shown uses Xd for motors, so it's actually basic calculation for momentary s-c current on a symmetrical basis. The article should so state this to avoid confusion.

(3) Xd for rotating machines (p 98) is synchronous *reactance* not steady state. For most machines this value exceeds 100%.

(4) Article should point out that momentary duty is usually the determining factor in selecting breakers for plants. This is often overlooked.

T O SWEATT, *Carlson & Sweatt, New York, N. Y.*

The author replies

I have two points to make on Mr Sweatt's first statement: (1) Actually, an impedance is a general term and a reactance can rightfully be referred to as an impedance. (2) What I really had in mind when I referred to reactances as impedances was the fact that in most instances including the resistance parameters do not alter, for all practical purposes, the reactance values used in the diagram.

The second comment is well put. The example covers only the momentary duty part of the short-circuit problem. For the same example to apply to interrupting duty, the synchronous motors would have to be represented by their transient reactance and the appropriate interrupting multiplier would have to be used. Any induction motors would drop out of the picture since their feedback lasts only about two cycles.

The third comment involves terminology. Synchronous reactance is the machine reactance under steady-state conditions; for this reason I refer to it as the steady-state impedance. I agree that synchronous reactance is generally greater than 100%.

Since magnitude is mentioned, it's interesting to note that were it not for an increase in excitation the short-circuited machine would, once the transient subsides, deliver less current than the normally loaded machine.

Mr Sweatt's fourth comment is noteworthy. Wherever an induction-machine load predominates, the interrupting duty is nil whereas the momentary duty is a very significant factor.

A H KNABLE, *Allis-Chalmers Mfg Co*

EDITOR'S NOTE: *Mr Sweatt also noted, as we know other readers will, the error involving the heading of the last column of the table in asymmetrical current calculation, p 99. The heading should, of course, be* Induction motor.

Look before you leap

Since he's concerned with what he terms a flyash "sputnik," POWER, Jan 1958, p 140, you can also assume that Mr Stevens hasn't visited our area. If he had, he'd have learned there's a great deal of activity afoot. He should become acquainted with *Durosil*—produced through the teamwork of my company and Rochez Bros of Pittsburgh. Suffice it to say that this product involves profitable utilization of many, many tons of flyash.

I might add that while our Shippingport plant is primarily famous for its nuclear reactor installation, it's an interesting fact that flyash was used extensively in the concrete poured during construction of the plant's buildings.

There are many uses to which raw flyash is being put in this country today, but this does not mean we're not aware of the potential of sintered ash. Sintering plants are definitely in our future. We have the know-how—it's simply a matter of economics governing the situation at present.

DR S F WHIRL, *Duquesne Light Co, Pittsburgh, Pa.*

. . . U.S. engineers are right on top of the flyash situation. Aside from use in ready-mix concrete and block for construction, flyash is being tried as a polyethylene filler and is used for industrial flooring. Near Pittsburgh, there are several highway test strips that are proving flyash as an additive for both concrete and bituminous paving. Research is underway at several universities and market development is carried on by many flyash producers.

As for brick, we could match anything turned out in Europe, but we've got many good brick-clay pits in this country. It costs less to locate brickyards at pits than to haul flyash to a brickyard.

Flyash handling and storage problems are more severe in this country because of large tonnages involved. Sintering seems the most attractive outlet but other available aggregates make economic circumstances different than in Europe.

HANK RUSSELL, *Bituminous Coal Research, Inc, Pittsburgh, Pa.*

Maintenance and Steam Traps

. . . there's a relationship that goes far beyond trap maintenance alone

Good traps and good trapping have a greater effect on your maintenance costs than does trap maintenance itself. By that we mean that the right traps, properly selected and installed, and with the benefits of a preventive maintenance program, will save far more maintenance dollars than they will cost.

Under the pressure of spiralling maintenance costs, this thought becomes mighty important. Let's take a look at what it involves:

Proper Selection of Steam Traps

1. Be sure it's the right type of trap.

2. Be sure it's sized right and is for the correct operating pressure.

3. Be sure it's first rate in design and construction.

Proper Installation of Steam Traps

1. Install them so they are accessible for inspection and maintenance.

2. Install a test valve.

3. Use a union or unions.

4. Use a shutoff valve or valves.

5. Use a strainer ahead of the trap if dirt conditions are bad.

6. Use a by-pass only where continuity of service is imperative.

7. Standardize inlet and outlet connections.

Preventive Maintenance Program

1. Test trap regularly for proper operation. (Trap size, operating pressure and importance determine frequency.)

2. Inspect internal mechanism at least once a year.

You Get Indirect Benefits As Well

The direct benefits of the plan outlined are pretty obvious — good traps, properly selected, require less maintenance . . . testing and inspection prevents troubles that lead to maintenance.

However, this plan provides indirect benefits which reduce maintenance in other parts of the plant as well:

Good traps save steam and reduce the load (and consequently maintenance) on fuel handling and burning equipment and on ash handling equipment.

Good traps protect the system by eliminating water hammer and preventing the damage it can do.

Good traps discharge carbon dioxide before it can go into solution to form corrosive carbonic acid — less corrosion, less maintenance.

Good traps increase production to reduce the length of time equipment must operate or reduce the amount of equipment needed . . . either way maintenance is reduced.

How to Go About It (The Sales Pitch)

We admit we're prejudiced, but we don't think there is any better way to select steam traps than with the help of the 44 page Armstrong Steam Trap Book. Here in a single source is specific data on the selection and sizing of traps, how to install them for best results, and how to maintain them most economically.

The Steam Trap Book will also give you full information on the design and construction of Armstrong Inverted Bucket Steam Traps that offer these important maintenance-reducing advantages:

1. Armstrong Traps are dependable.

2. Armstrong Traps require no adjustments — go from full load to zero load automatically.

3. Armstrong Traps are self-scrubbing—ordinary dirt conditions can't hurt them.

4. Armstrong Traps have long-life parts — valve and seat are heat treated chrome steel — lever assembly and bucket are stainless steel.

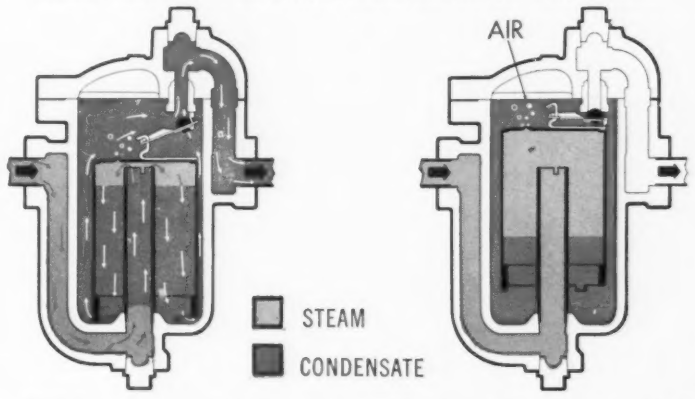
5. Armstrong Traps have water sealed valves to minimize wire drawing and erosion.

Ask for your copy of the Steam Trap Book—there is no obligation. Then test Armstrong Trapping. If you are not completely satisfied with the results, you can return the traps for a full refund of the purchase price. You can't lose much that way. Call your local Armstrong Representative or Distributor, or write

Armstrong Machine Works
8122 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

HERE'S THE STEAM TRAP DESIGN
THAT CAN REDUCE YOUR MAINTENANCE PROBLEMS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

GETTING READY to enter 1200-F furnace, D J Bennett, ceramic engineer, dons an aluminum-coated, glass-fiber-insulated suit

How to
walk into 1400 F

Now your men can dress in aluminum-coated, glass-fiber-insulated suits that have withstood 1400 F. Garments include coats for firemen; long-coats, aprons, spats, and gloves for steel worker; coats, suits, gloves and helmets for standby fire-fighting equipment in industrial plants; quilted suits with aluminum-coated fabric exteriors for industrial ovens and furnaces; suits for emergency personnel at airports, oil fields and other locations where emergency action can save time, money and lives; other garments for specific "hot jobs" in specific industries.

Pictures here demonstrate the heat-protective qualities of fabrics coated with a thin layer of aluminum that reflects radiant heat instead of insulating against it.

This permits less bulky insulation, so a man can work at temperatures higher than ever before to repair, investigate, inspect, rescue or extinguish. Suit has been worn in 1400 F for several minutes' exposure—much higher temperatures for a matter of seconds without feeling heat.

Coated aluminum on asbestos and cotton duck is a stock item. Now glass fiber and other such materials are coated.

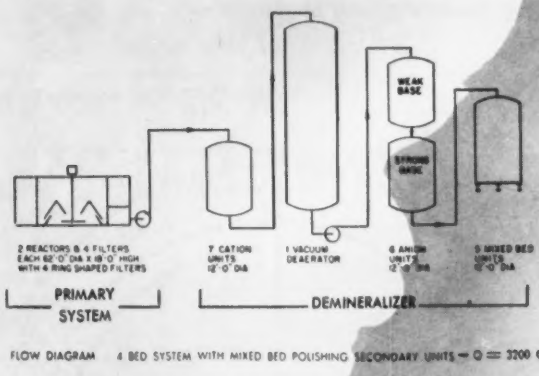
One firm reports saving 35,000 man-hours in production time because an aluminized suit permitted an engineer to enter a hot zone immediately and make a 10-min repair. Otherwise the firm would have had to shut down production for several days' cooling-off period until the repair could be made, then reheat for several days before resuming production.—*Courtesy, Minnesota Mining and Manufacturing Co, St. Paul, Minnesota*

MANIKIN of cloth bursts into flame

WICKER CHAIR next bursts into flame

WOOD bursts into flame from the heat

LEADERSHIP IN WATER CONDITIONING


WEAK BASE
STRONG BASE
2 REACTORS & 4 FILTERS EACH 62'-0" DIA X 18'-0" HIGH WITH 4 RING SHAPED FILTERS
7 CATION UNITS 12'-0" DIA
1 VACUUM DEAERATOR
6 ANION UNITS 12'-0" DIA
5 MIXED BED UNITS 12'-0" DIA
PRIMARY SYSTEM
DEMINERALIZER

FLOW DIAGRAM 4 BED SYSTEM WITH MIXED BED POLISHING SECONDARY UNITS — Q = 3200 GPM

LINDEN

Cochrane DEMINERALIZER

protects high pressure boilers and turbines at Linden Generating Station

WATER ANALYSIS In Parts Per Million

	Raw Water	Final Effluent	
Turbidity	3-46	0 to 0.5	Primary Treatment
Color	40-160	0 to 2	
Total Hardness as $CaCO_3$	26-164	0	Demineralizer
Alkalinity as $CaCO_3$	66-183	0 to 0.1	
Silica as SiO_2	3-12	0 to 0.01	
Dissolved Oxygen as O_2	Saturated	0 to 0.1	
Total Dissolved Solids	100-520	0 to 0.2	

TREATING PLANT

- 2—Solids-Contact Reactors, 62' dia. x 18' high, with four peripheral gravity anthracite filters. — Primary Treatment
- 7—Cation Units, 12' dia.
- 1—14' Vacuum Deaerator, rubber-lined.
- 6—Weak Base Anion Units, 12' dia.
- 6—Strong Base Anion Units, 12' dia.
- 5—Mixed-bed Polishing Units, 12' dia. — Demineralizer

Public Service Electric and Gas Company's new Linden Generating Station features the most outstanding Demineralizer Plant ever installed. The system, designed and manufactured by Cochrane, treats 30 to 100% make-up for boilers with design pressures up to 2700 psig.

Some of the unique features include complete automatic remote control for both primary treatment and Demineralizer Plant . . . Filter and demineralizer backwash recovery for re-use . . . Re-use of most anion rinse water . . . Low acid consumption . . . Silica reduction in two stages: first, by strong base primary anion units, then by mixed bed secondary units . . . Low caustic soda requirements . . . Resins cleaned by brine automatically. These and many other features assure the ultimate in efficiency for this plant.

Cochrane's years of experience in the design and manufacture of every type of water treating equipment are your assurance of continuing satisfactory performance.

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Continuous Blowoff Systems • Condensate Return Systems • Steam Specialties

Basics . . . bringing engineering theory down to earth

NORMAN PEACH, Assistant Editor

Electricity: 18

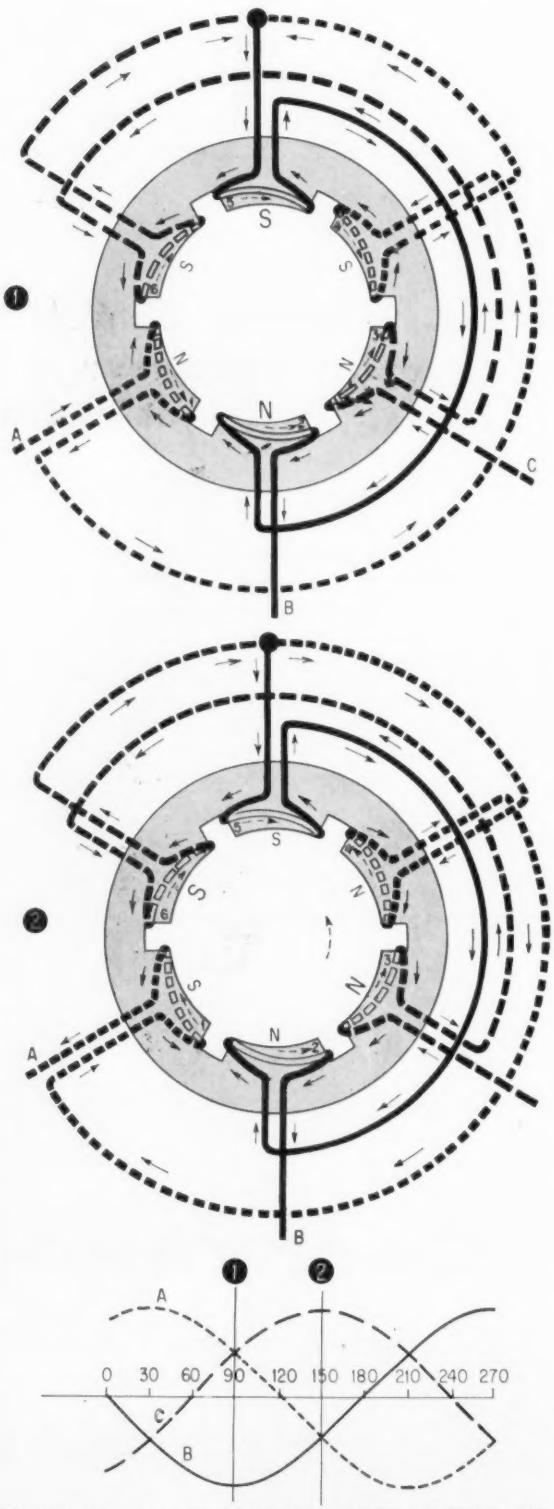
What makes induction motors run?

Induction motors have the ac power supply connected to a winding on the *stator*, or stationary part of the machine. Compared with dc motors, the stator occupies the mechanical position of the field, but electrically it is the armature. Induction motors can also be compared to transformers: the stator winding is equivalent to the primary, and the *rotor*, or rotating part, is equivalent to the secondary. The rotor has a winding embedded in fits slots that is closed and has no connection to the power supply. A voltage is induced in the rotor winding, as in a transformer secondary. The rotor current produces a magnetic field which reacts with the stator field and causes rotation. Rotor winding may consist of coils similar to stator winding, but commonest type is the *squirrel-cage*. Solid bars in the slots are welded or cast to metal rings at rotor ends.

Rotation in the three-phase induction motor is caused by a rotating magnetic field set up by stator windings. Sketch 1 shows a simplified two-pole stator. Three coils, one for each phase, make up a pole. Coils that are mechanically opposite are connected for opposite magnetic polarity. North pole N-N-N consists of coils *1*, *2*, *3*. Its center is at coil *2*. The three motor leads *A*, *B*, *C* are connected to corresponding phase wires. For conditions shown in sketch 1, phase relations are like those at 90 deg. Currents *A* and *C* in coils *1* and *3* are positive, equal and one-half maximum value. Current *B* in coil *2* is maximum, but negative. Notice, however, that the connection of coil *2* is reversed; thus *2* has same magnetic polarity as *1* and *3*.

Poles have shifted counterclockwise in sketch 2, 60 electrical degrees later. Current *A*, in coil *1*, is now negative; polarity of coil *1* has reversed, and it is now part of south pole S-S-S. At the same time, polarity of coil *4* reverses, and it becomes part of the N-N-N pole. Current *B* in coil *2* has decreased to half maximum while *C* in coil *3* has increased to maximum. Centers of poles have rotated 1/6 of circumference.

Rotor poles follow stator poles, torque is developed. Rotor does not travel quite as fast as stator poles. Depending on load, there's a difference in rpm called *slip*. An 1800-rpm motor runs about 1750 rpm loaded.



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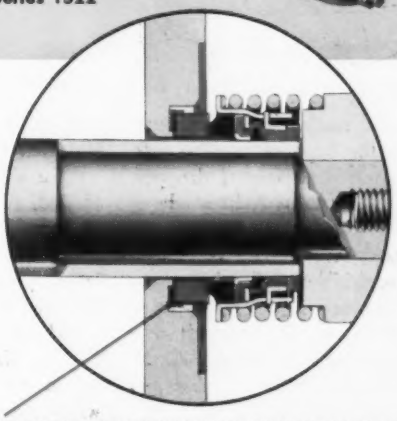
ORDER A B&G STOCK PUMP!

B&G maintains a factory stock of the most commonly used sizes of centrifugal pumps for immediate delivery. Base mounted and integral-motor pumps as listed in B&G Stock Pump Catalog are available in capacities to 325 GPM, heads to 140 ft.

Why B&G Centrifugal Pumps give years of trouble-free service is evident from their design features. Vertical split case construction permits removal of the bearing bracket without disconnecting pipe lines or motor leads. Special alloy steel shafts are super-finished and over-sized to keep deflection at a minimum.

Leak-proof operation is assured by the "Remite" Mechanical Seal—an exclusive B&G development. "Remite" is so hard it will cut glass—eliminates packing rings and gland adjustment. Seal is self-lubricating.

Send the coupon for catalog



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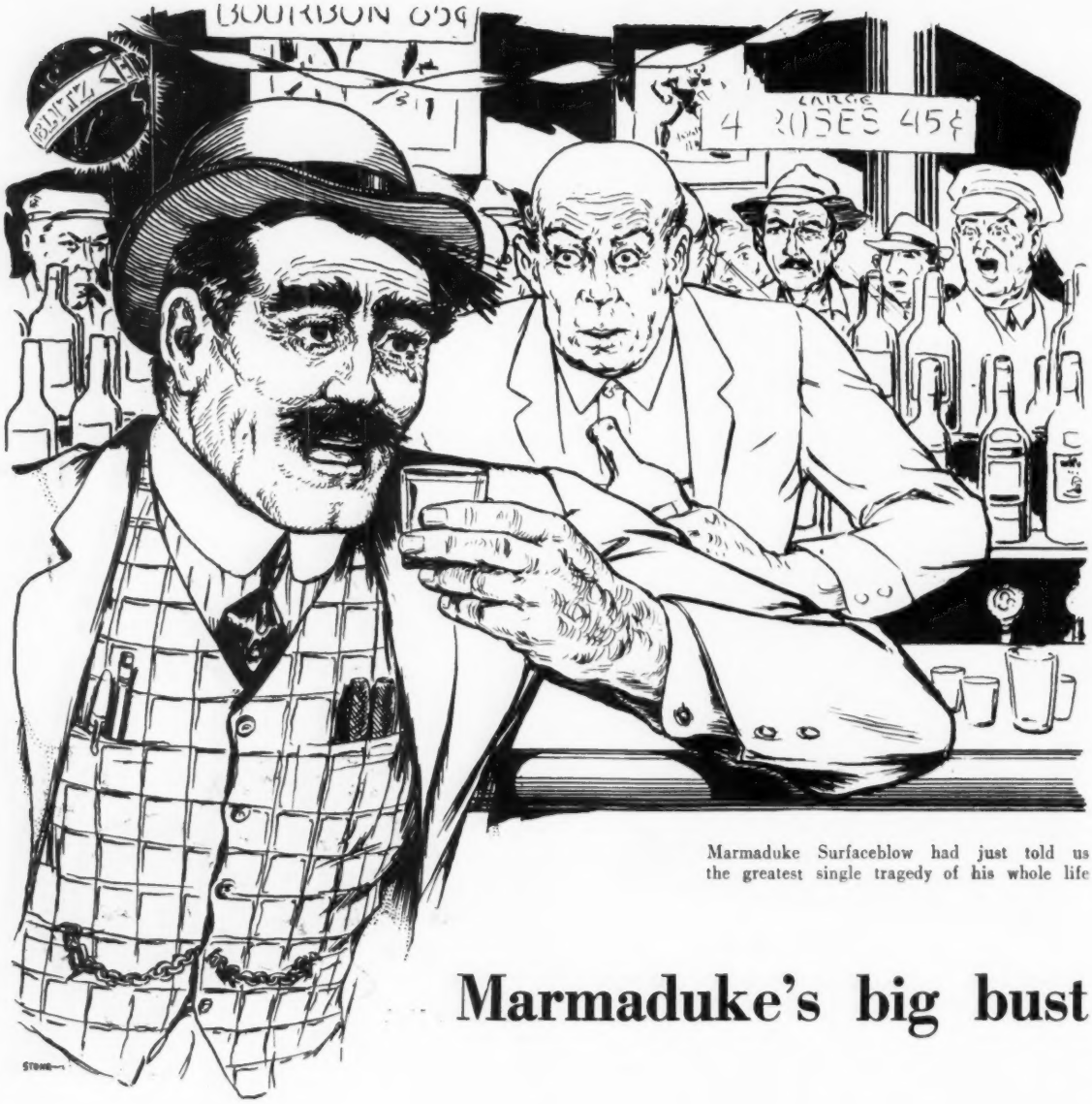


Marmaduke Surfaceblow had just told us the greatest single tragedy of his whole life

Marmaduke's big bust

I often visit Bedlam's Bent Propeller Bar in the hope of running into old shipmates. Last week I dropped in and found Warren A Prest chewing the fat with our editor-at-large, Marmaduke Surfaceblow. Warren is an old-time ship's captain who settled down ashore selling boilers.

Just as I edged through the crowd, Marmaduke bellowed, "BILGEWATER!" So I grabbed a table and relaxed while he sounded off.

"Back in 1921 I shipped aboard the *SS Strathaver* on a pier-head jump," croaked Surfaceblow in his rumbling voice. "Her old chief had had one snort too many and tumbled down the fireroom fiddley just before sailing time. Because the first assistant didn't have chief's papers, the port engineer sent me an SOS at my Hoboken boarding house.

"We shoved off as soon as I got aboard. Afterwards, I learned we were making a tramp run. That trip we hit the Africa West Coast, Canary Islands, Portugal, Spain, France, Holland and England.

"While loading at Las Palmas, Canary Islands, I heard that a bonded warehouse was closing out their whole stock of Scotch at $9.60 a case. I wasn't too particular in those days, so Scotch was OK—especially at $9.60 a case. But, as my luck usually runs, everyone aboard got wind of it at the same time. When delivery was made, the Scotch came alongside in a scow and had to be hoisted aboard with the cargo gear. I was a little short on cash that trip and got only 20 cases for myself—just enough to fill my shower stall.

"In those days, the custom inspectors boarded a ship coming in from a foreign port soon as she lowered the gangplank. All contraband found was confiscated. But, with Scotch selling at $20 a bottle in the U.S., I didn't intend to leave my stuff in the bathroom for the 'forty thieves' to find. And those boys really knew all the hiding places.

"Two weeks later we anchored at Baltimore. That night the captain told me we were being towed into the Pratt Street pier at six am, and he wouldn't need the engine. That wasn't regular, but it was the break I needed. (*Continued on page* 178)

ONE-SHOT "BOILER TREATMENT" GETS UNEXPECTED RESULTS

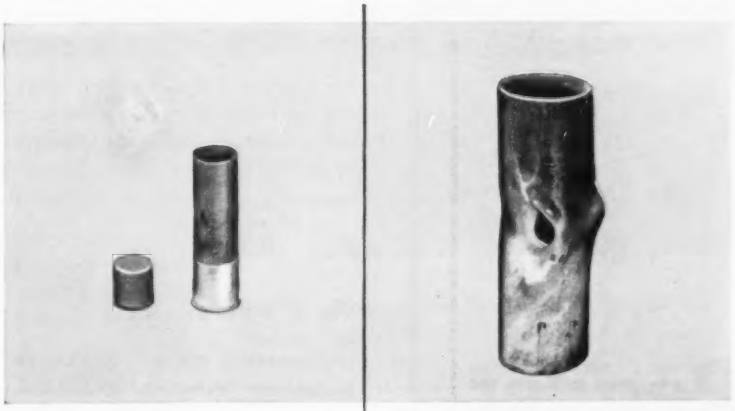
CEMENT MANUFACTURER SHOOTS THE WORKS!

CLEANING rotary cement-drying kilns by firing lead slugs into them to knock off accumulations inside is routine practice. The slugs go bounding and bouncing through the long drying kiln, doing a cleaning job equivalent to a whole crew of pick-and-shovel pilots. No one expects a slug to become so enthusiastic that it continues its chores inside the waste heat boiler attached to the far end of the kiln. In fact, the odds against getting a slug into the boiler *on purpose* are astronomical. But this one got there, odds and all, thus establishing a new type of one-shot boiler treatment which is hardly likely to become popular.

HOWEVER, *inside* the boilers at this large cement plant, Nalco System treatment helps make certain that boiler troubles, if any, are on the outside. Boiler feedwater is aerated, filtered, zeolite softened, evaporated and deaerated. A Nalco corrosion inhibitor is fed between deaerators and feed pumps for corrosion control throughout the steam and condensate return systems. Nalco catalyzed sodium sulfite does the oxygen scavenging on the discharge side of feed pumps. A Nalco internal treatment and caustic soda are fed directly into the boiler for pH control and scale prevention.

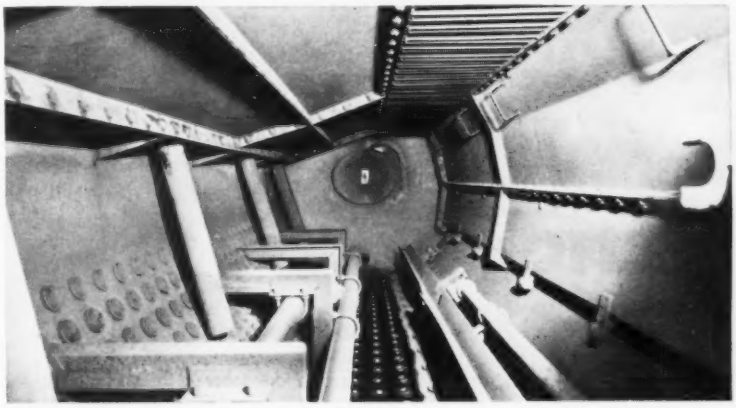
It is no wonder these boilers can turn out 169,000 lbs. of steam per hour, year after year, and stay like new—except, of course, for the wayward shotgun slug.

Nalco has not yet developed bullet proofing for boilers . . . But you can never tell what may come next! Meanwhile, we'll be happy to tell you more about effective Nalco Internal Treatment. Ask for Bulletin B1. National Aluminate Corporation, 6222 West 66th Place, Chicago 38, Illinois. In the Northwestern United States, Hawaii and Alaska: The Flox Company, Inc., Minneapolis, Minnesota. In Canada: Alchem Limited, Burlington, Ontario. Branches and affiliates in Spain, Germany and Italy.



THE TREATMENT: Lead slug, propelled by heavy powder charge in 8-gauge shell fired from a miniature cannon! "External treatment" with a vengeance.

THE RESULTS: "Plugged" boiler tube, pierced by lead slug on the pay off to one chance in a million. Internal treatment powerless here.



Steam drum in one of the Nalco-treated boilers at cement plant is typically clean and corrosion-free when opened for annual inspection.

Water treatment chemical mixing and proportioning room, where Nalco System treatment starts on its way to give complete steam system protection against scale and corrosion.

Reader service section

Start with these quick samples...

Our roving reporter . . .

has just come back from the frozen north, wrapped in muffler and arctics, and he announces that they're certainly keeping cool in Canada. Not only is winter raging, but engineers are cooling even the electrical cables—by running cold-water piping beside them. "A very ingenious proposition!" our man said, heading for the radiator . . .

Reports from the field, p 150

Check with us . . .

for time-saving abstracts of latest technical reports. Recent developments in computer technology and the continuing use of large single boiler units make cycle-performance monitoring both necessary and practical, so we hear, and we've digested a paper on the subject, plus others on controls, feedwater and air pollution . . .

Technical briefs, p 152

Just off the boat . . .

is a distinguished visitor, arriving in America after reported successes on the Continent. We were waiting at the dock when the ship pulled in, and the newcomer turned out to be a diesel engine for powering small industrial equipment. We rushed back to the office and listed relevant details—with a slight British accent—in . . .

Plant equipment news, p 156

Looking over the field . . .

can be done by mail, believe it or not. We mean the power field, via a new batch of manufacturers' bulletins. Tear out a postcard, affix a stamp to one side, your signature and the numbers of the books you want to the other, and we'll contact the manufacturers, who'll see that their latest literature is waiting in your mailbox . . .

Free literature, p 163

Time to retire . . .

not for this man! At the age of 82, Elijah Williams is busy in his boiler shop, supervising construction of a wet-back Scotch marine boiler designed by himself to revolutionize the old hrt. We think the secret of his vitality is faith in himself, backed up by hard work, and we think it's wonderful. For the full story, consult . . .

George Edwards, p 166

For other timely ideas, see following service pages▶

INCREASED PRODUCTION with GREATER FUEL ECONOMY

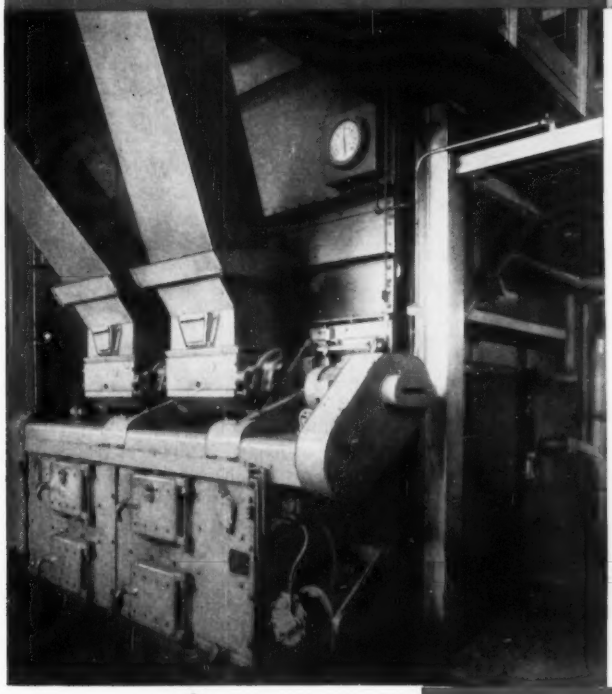
Smokeless Operation

DETROIT ROTOSTOKER TYPE C-C

(Continuous Cleaning)

at Carlisle Tire and Rubber Division

CARLISLE, PA.



It is not uncommon for the Detroit RotoStoker, Type C-C to make fuel savings ranging from 10% to 25%. Where process steam is used in production, as in this plant, fuel economy is usually accompanied by a substantial production increase.

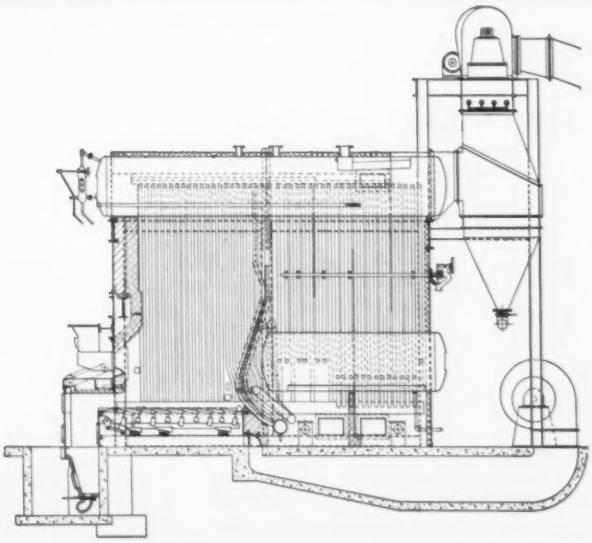
In addition the Type C-C provides smokeless operation at light loads as well as at full capacity—important in built-up areas.

Other advantages of Type C-C are:

- **Continuous uninterrupted steaming.**
- **Ample capacity and high availability.**
- **Quick response to load fluctuations.**
- **Fuel feeders and distributors handle high moisture coals without clogging.**
- **Available to develop 5,000 to 75,000 lbs. of steam per hour.**
- **Easily applied to new or existing boilers.**
- **Low Maintenance.**

Detroit RotoStoker Type C-C (continuous cleaning) in the plant of Carlisle Tire and Rubber Division of Carlisle Corporation. This unit has a capacity of 25,000 pounds of steam per hour. Either West Virginia or Pennsylvania 13,500 BTU coal is used.

Keeler Type CP Boiler with Detroit RotoStoker Type C-C. Ashes discharge at front, are removed by a conveyor. No basement is needed.



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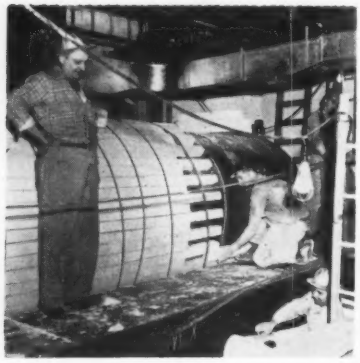
Reports from the field

What's happening in power and what it means to you



Shippingport plant has special insulation needs

"Safety" was the watchword in construction of the Shippingport atomic plant. Engineers, keenly aware of public-relations hazards involved in even a minor nuclear industrial accident, drew up rigid specs for the first full-scale commercial atomic plant, and even thermal insulation got a close look.

Insulation also presented material and application problems. High thermal efficiency was a must, since reactor vessel would generate temperatures up to 650 F, but material had to be absolutely "clean," contain no element which (*Continued on page* 224)

Three 1055-bhp compressors are off to Australia

Three compressors weighing a total of more than 180 tons plus 100,000 lbs of accessory equipment are on their way to the Kwinana, Australia refinery of British Petroleum Co Ltd. High-capacity crane, floating derricks were used at packing plant and dock, car floats transported crated 25 × 13 × 11-ft units to the steamship. Type GMVL-10 gas-engine driven reciprocating compressors rated at 1055 bhp, 300 rpm, 1000 psi were manufactured by Cooper Bessemer Corp. They will compress hydrogen-rich gas from 386 to 600 psi for use in a new Aussie catalytic reforming unit.

For Calendar of Events see page 224

Cold-water piping boosts cable capacity

MONTREAL, MCGRAW-HILL WORLD NEWS—Big savings in cable and installation are predicted for Canadian utilities by the Hydro-Electric Power Commission of Ontario. Ontario Hydro has worked out a tentative solution to problem of limited capacity of underground cables, plans to increase capacity by running polyethylene water pipe alongside new cable installations. Power transmission heats cables, temperature remains high when underground cable passes through soil with low thermal conductivity. These "hot spots" reduce cable capacity. In new development, cold water cools soil, keeps temperature down to safe levels so additional power can be fed through cables.

First application of new principle is in Toronto. Over 30 miles of ¾-in., five miles of ½-in. cold-water pipe are being laid beside the twelve 115,000-v cables. Piping and controls are expected to add only 5% to costs, boost capacity 50 to 60%. Cooling water will be used direct from municipal mains, at normal temperature and pressure.

Power lines

The bituminous coal industry, major coal users and material and equipment suppliers have joined to establish a new coal research center in Pittsburgh, Pa.

A British labor union whose members tend large batteries of equipment at remote stations is asking "lonesome pay" to compensate for the pains of isolation.

Two diaphragm control valves weighing two tons each and requiring 155 hours to machine will control steam flow from Philadelphia Electric Co's Edison plant.

Columbia U. chemists are taking up modern alchemy—changing coke to methane, major ingredient of natural gas. A 20-lb 1400-curie block of cobalt-60 provides radiation to catalyze hydrogenation process.

Variable-speed Jupiter gas-turbine engine to power a work boat develops 500 hp in 71 cu ft of space. Unit was developed by Solar Aircraft Co.

World's first commercial transformer to use high dielectric-strength gas has been operating for eight months. Unit was developed by Westinghouse; uses a fluorochemical and sulfur-hexafluoride as coolant.

Engineers Joint Council (29 W 39th St, New York 18, N. Y.) has a handbook for consultants and clients. *Practice of Consulting Engineering* costs $1.50.

Silver-plated aluminum bus conductors now commercially available for electrical installations make it possible to solder or braze connections.

A. P. GREEN

Plastic and Castable Monolithic Linings Give Higher Operating Efficiency... Lower Maintenance Costs in Watertube Boilers

Monolithic refractory linings, properly installed, give better combustion efficiency and longer service life than any other type lining.

During operation, the sections of a furnace are subjected to different conditions. Each A. P. Green product has been developed to meet the service requirements of the zone for which it is specified. A. P. Green plastic and castable furnace linings installed under the supervision of trained personnel give you the full benefit of monolithic construction, plus the advantages of "zone-rated" materials.

SUPER HYBOND is a special super duty plastic that develops high strength throughout its entire thickness... regardless of furnace operating temperature. It is ideal for use in spreader stoker arches and piers, behind waterwall tubes, and as a seal around tubes where they pass through the wall.

SUPER-PLASTIC... a super duty plastic designed for use where operating conditions are unusually severe. Gives excellent service in complete monolithic linings, side walls in furnace area, flat suspended arches and spreader stoker arches. Patching and repairing firebrick or plastic linings with SUPER-PLASTIC results in longer, more efficient service.

PLASTIC QUIK-PAK... a high duty plastic refractory which combines refractoriness, low shrinkage and hot load bearing strength. It is used in constructing monolithic side walls and in patching those portions of watertube boiler linings which do not require super duty plastic.

KAST-SET is a high quality refractory castable which develops a strong hydraulic bond without application of heat. Recommended for convection sections of watertube boilers, baffles, waterwall backing, linings for stacks, breechings, flues, and ducts.

KAST-O-LITE is a lightweight, insulating castable refractory for temperatures up to 2500° F. Used for monolithic linings in convection sections of boilers. Reduces heat loss. Insures closer temperature distribution and control.

For properly engineered monolithic linings call your A. P. Green distributor —he's listed in the yellow pages of your telephone directory.

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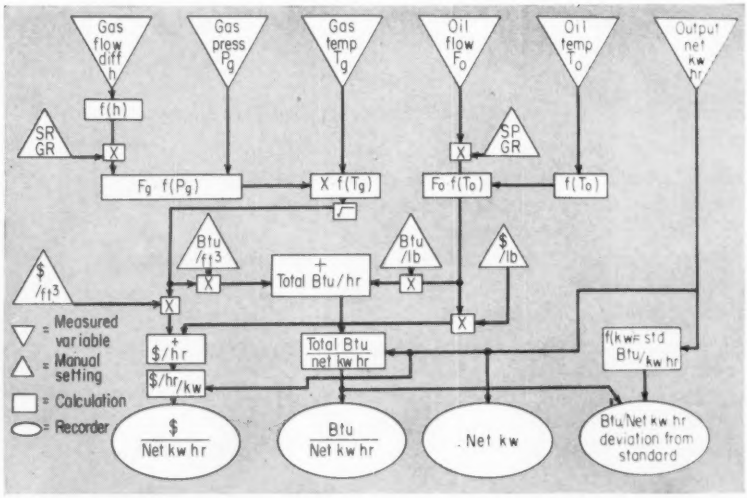


INPUT-OUTPUT method for determining performance is limited to gas-, oil-fired units

Computers monitor plant performance

Continuous monitoring equipment for power plant cycles. *By T S Imsland and A J Hornfeck, Bailey Meter Co*

Recent developments in computer technology and components, trend toward use of large single boiler and turbine-generator units have established the need and made possible the monitoring of cycle performance. This paper describes equipment that has been developed to monitor continuously on a real-time basis by feeding information in the form of measured data of the cycle directly into an analog computer. Computed outputs such as boiler efficiency, turbine-cycle heat rate and overall-cycle heat rate are obtained which are criteria of unit performance. These outputs are indicated and recorded continuously; in some instances may be converted into digital form for data logging.

Two methods of determining unit performance are used, the input-output and the heat-loss methods.

Because of inaccuracies involved in an attempt to measure coal flow, input-output method is limited to gas- and oil-fired boilers. A given percent error in the measurement of either input or output results in substantially the same error in the result; namely, boiler efficiency. Errors in measurement of fuel or generator output have a direct proportional effect on computed unit efficiency. Heating value of the fuel is determined by test and manually entered into the computer. Sketch above shows a typical input-output block diagram.

The heat-loss method of determining overall unit performance is applicable to all types of fuels. More specifically, it applies to coal which cannot be metered with any great degree of accuracy.

Boiler losses ordinarily run in the neighborhood of 10-15%, so a reasonable error in their measurement would result in a very small error in the final result. For example, a 1% error in measuring boiler losses would appear as a 0.10-0.15% error in determining boiler efficiency. Other factors being equal, greater accuracy can be attained by the heat-loss method than by the input-output method. For this reason the heat-loss method is generally adopted in conducting acceptance tests. Sketch, page 154, shows typical heat-loss method block diagram. *ASME paper, No. 57-A-176*

Application of the analog computer to predict dynamic performance in typical hydraulic circuits. *By G Reethof, Vickers, Inc*

Successful use of electronic-analog computing techniques in the simulation of typical hydraulic systems is demonstrated. As an example, the instabilities of a certain open-center hydraulic booster system are simulated, corrective action is indicated and verified. The study involves analysis of a grossly nonlinear system and methods of function generation are given.

Author concludes that the electronic analog computer can be programmed to realistically simulate nonlinear hydraulic circuits. Validity of the simulation depends entirely on the analyst's ability to realistically describe the behavior of the system elements by analytical means. Thus the analog computer will only solve the engineers' analytical interpretation of the system. If important distributed or lumped effects are neglected, the answers from a computer may be embarrassingly misleading.

If, however, a reasonably accurate simulation is studied by the analog approach, an excellent physical understanding of the nonlinear system is obtained. *ASME paper, No. 57-A-97*

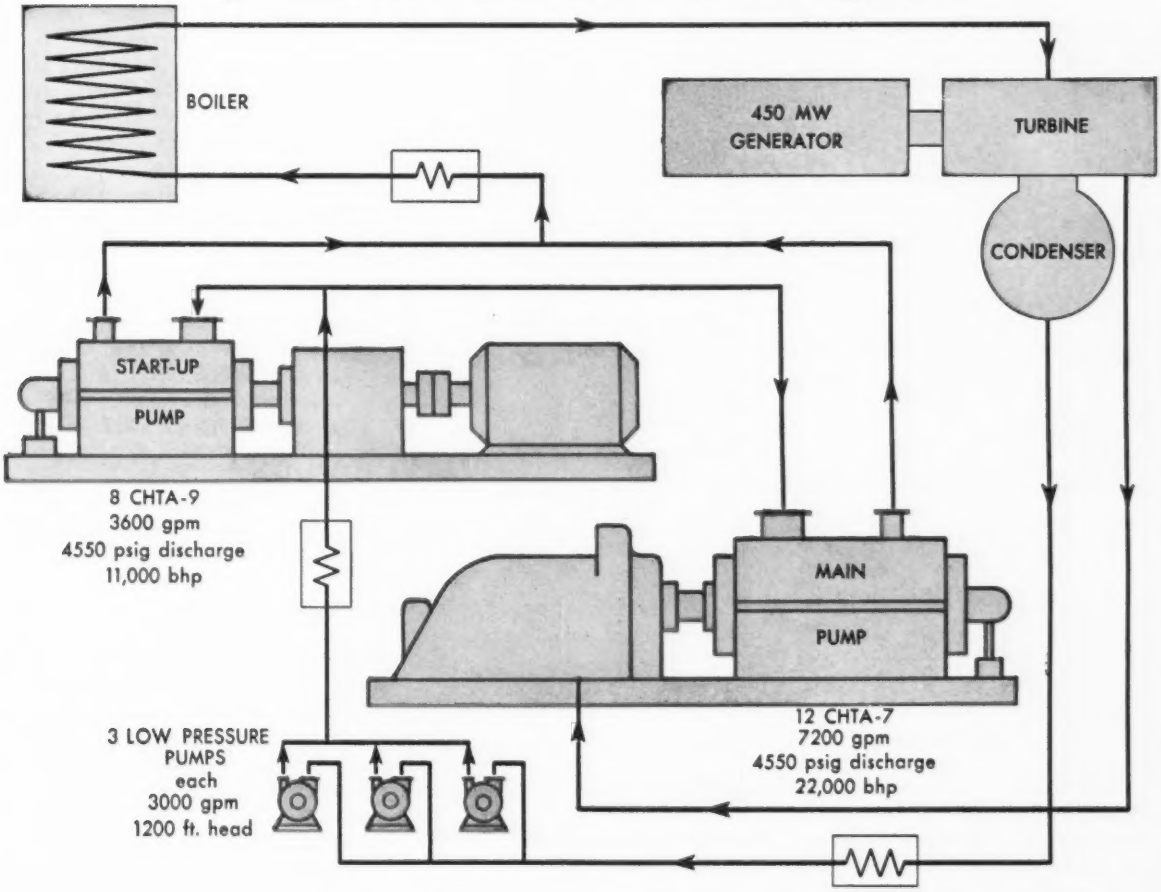
Controls

Continuous pump control by a dual pneumatic circuit. *By E R Forman and W R Jensen, Moore Products Co*

A method of liquid-level pump control (believed to be more flexible than previous arrangements) has been installed at the new Penns

WORLD'S BIGGEST BOILER-FEED PUMPS

will serve two 450 MW Generating Units of American Gas and Electric System



I-R Pumps rated 22,000 hp and 7200 gpm will set new world's record for power and capacity

American Gas and Electric System will make power-plant history with the construction of two tradition-shattering 450 MW generating units—one for a new station operated by the Indiana & Michigan Electric Company and the other for Ohio Power Company's Unit No. 5 at Philip Sporn Station.

Both of these installations will be served by Ingersoll-Rand boiler-feed pumps—5 units each, connected as shown in the diagram above. Particularly noteworthy is the 7-stage Class CHTA main boiler-feed pump, the largest unit ever ordered, driven by a 22,000 hp steam turbine.

For the highest capacities and pressures, Ingersoll-Rand CHTA boiler-feed pumps are first choice with America's leading power plants. For reasons why, ask your I-R representative.

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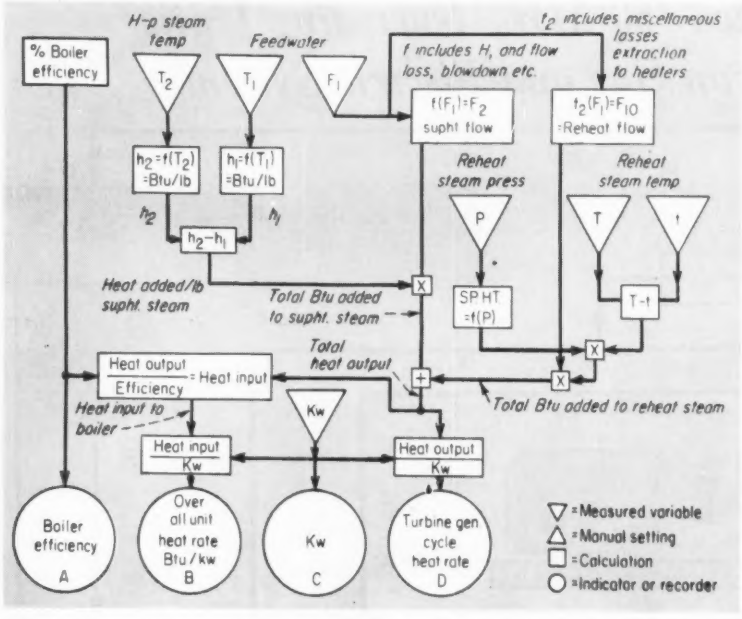
More **technical briefs**

Begins on page 152



HEAT-LOSS method for monitoring power-plant cycles is applicable to all fuel types

Grove, N. J. Sewerage Authority Treatment Plant. Switchover and loading of the pumps are accomplished by a dual pneumatic proportional-band circuit, coupled with electrically operated pumps.

Pump-speed control is varied continuously by a pneumatic system, at every level of the wet well. Loads on the pumps can be distributed, both automatically and manually, in any desired sequence. All operations of pumps can be controlled from the front of the panel. *ASME paper, No. 57-A-53*

On-off control with periodic sensing device. *By K Izawa, Purdue University*

The paper describes theoretically the effectiveness of PD-type control function for the on-off control system with a periodic sensing device. When the system is disturbed by a steady random disturbance, provided that the disturbance is varying rather slowly compared to the time constant of the controlled plant, the properly chosen PD control action can effectively decrease magnitude of fluctuation of controlled variable. *ASME paper, No. 57-A-207*

Directions for ordering papers on page 188

Feedwater

Diet for boiler allergies. *By S F Whirl, Duquesne Light Co*

When either design or operation of a boiler presents critical problems, chemical conditioning of boiler water assumes special importance. Effectiveness of a particular method, however, is limited by severity of the conditions imposed by both design and operation.

This paper considers chemical conditioning in this light, stressing advantages and limitations of co-ordinated phosphate-pH control method of boiler-water conditioning. Considered also is the use of auxiliary chemicals such as sulfite, hydrazine, alkalizing amines and ammonia, and the numerous design and operation factors involved in evaluation of any boiler-water treatment method. *ASME paper, No. 57-A-257*

Ammonia and hydrazine for high pressure boilers. *By R I Smith, Public Service Electric and Gas Co*

Six boilers in the Public Service Electric and Gas Company system which operate at pressures in excess of 2000 psig have been in service for periods up to two years with ammonia and hydrazine as the only water- and steam-conditioning agents.

This treatment method was adopted to reduce corrosion in the preboiler cycle and to minimize possibility of turbine deposits by eliminating addition of solids-forming chemicals to boiler water. Results to date indicate that satisfactory conditions are being maintained throughout the boiler, turbine and preboiler cycle with ammonia-hydrazine treatment.

Observations do indicate, however, that further experience is needed to permit a long-term evaluation of the benefits and limitations of this new method of treatment. *ASME paper, No. 57-A-248*

Air pollution

Principles of gas cleaning. *By R V Kleinschmidt, Stoneham, Mass.*

Although there is nothing abstruse or complicated about basic principles involved in cleaning gas, the practical development of gas-cleaning equipment, and the uncertainty in the minds of engineers as to proper type of equipment to use for a specific gas-cleaning job indicates that a clear statement of principles may be useful.

Author lists ten important considerations in gas cleaning, and describes the two basic steps in the cleaning process: (1) concentrating impurities by relative motion through gas and (2) removing concentrated impurities from contact with gas stream. He then describes several methods of causing relative motion through the gas. *ASME paper, No. 57-A-270*

Engineering problems in controlling automobile exhaust gases. *By W L Faith, Air Pollution Foundation*

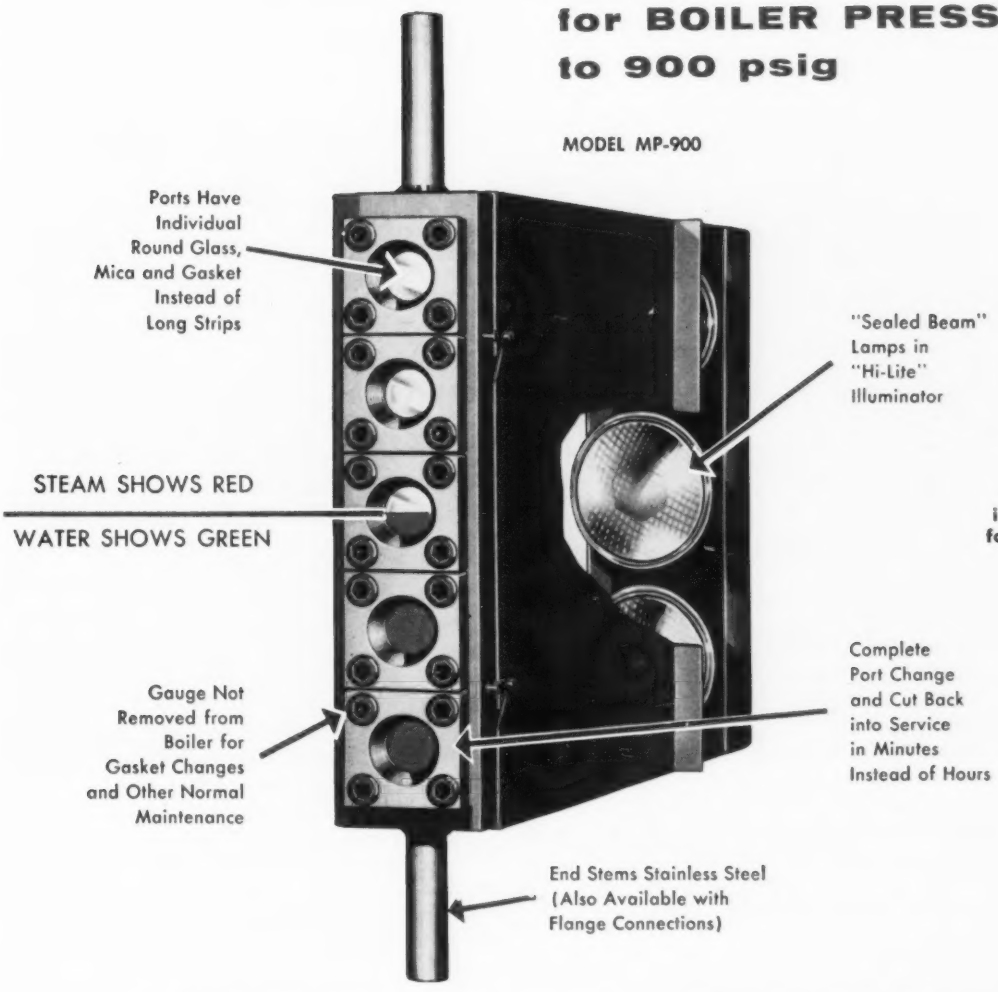
Research and development on methods to control air pollution from

(*Continued on page* 186)

Sure-Reading ...DIAMOND "Multi-Port" Bi-Color Gauge

for BOILER PRESSURES to 900 psig

MODEL MP-900


Ports Have Individual Round Glass, Mica and Gasket Instead of Long Strips
"Sealed Beam" Lamps in "Hi-Lite" Illuminator
STEAM SHOWS RED
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Also available is Model MP-3000 for boiler pressures to 3000 psig
Complete Port Change and Cut Back into Service in Minutes Instead of Hours
Gauge Not Removed from Boiler for Gasket Changes and Other Normal Maintenance
End Stems Stainless Steel (Also Available with Flange Connections)

The individual round ports each having its own round glass, round mica and round gasket (instead of the conventional long strips) means less stress and strain . . . resulting in greatly reduced maintenance. When replacement is required, it is usually only one port . . . which can be changed in a very few minutes . . . and without removing the gauge from the boiler.

The Diamond Bi-Color feature is another important advantage of the MP-900 Multi-Port . . . steam always shows red and water always shows green. There can be no question of the water level.

Recommended for both new and old boilers up to 900 psig, the MP-900 Multi-Port will give you a new standard of gauge operation. Use the coupon below for additional information.

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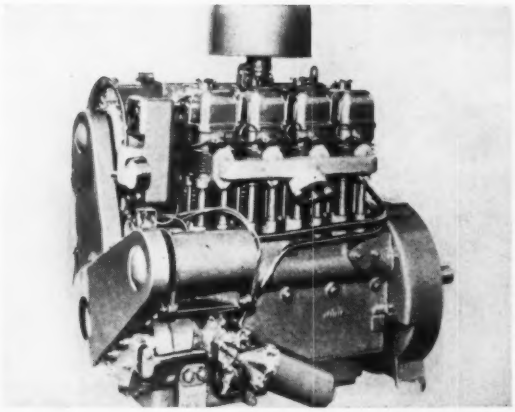
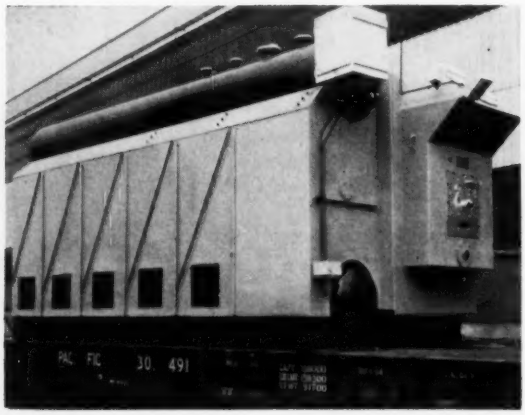


High-speed diesel powers light machinery

201 • High power-to-weight ratio diesel engines can be harnessed to small industrial equipment. Lightweight units operate at a constant speed of 3000 rpm, therefore are suitable for use with light equipment.

Units are air-cooled. Applications include powering air compressors, generators, conveyors and ventilating and refrigeration units. Single- to four-cylinder models weigh 243 to 503 lb, develop from 6.25 to 25 hp. The single-cylinder engine has a tunnel-bore crankcase, a flywheel-type cooling fan. Larger models come with underslung crankcases, high-level axial-flow fans. Manufacturer is Petters Ltd of England, U.S. distributor is—*Brush ABOE, Inc, 60-07 39th Ave, Woodside, N. Y.*



Packaged boilers increase capacities

202 • Large packaged watertube boilers come in ten sizes, 11-ft wide, 12-ft 4-in. high and 8-ft to 25-ft long for steaming rates of 10,000 to 45,000 lb per hr at pressures up to 250 psi. Superheat is available in the larger ratings.

Units are oil- or gas-fired with electric or pneumatic automatic controls. Large upper and lower drums, elimination of headers provide for free water circulation, according to manufacturer. Water-cooled furnace walls and crossflow of combustion gases in convection tube bank are said to improve heat-transfer efficiency. Tangent tubes form seal between furnace and convection sections. Special foundations are not needed. —*Dominion Bridge Co, Ltd, Lachine, Que., Canada.*

For more data on these items, use post cards on page 163. Identify your request with item number

Flexible flanged fitting

203 • Stainless-steel serrated insert with carbon-steel flange is designed for connecting lightwall stainless piping where possibility of future changes makes welding undesirable. Pipe is expanded directly into inset flange for leakproof connections, manufacturer claims. Serrated insert holds pipe to eliminate rotation. Lip holds flange to insert, allows it to be pulled up tightly against Neoprene or Teflon gaskets.—*Speedline Stainless Steel Fittings Div, Horace T Potts Co, 504 Erie Ave, Phila. 34, Pa.*

Portable grooving tools

204 • Portable tools are said to quickly roll grooves into lightweight pipe and tubing, without removing any metal. Tools, for use on the job or in the shop, are adjustable from 1¼- through 12-in. diameters. *Series 200* is constructed for continuous duty on heavier wall thicknesses, *Series 100* is designed for lighter duty. Either unit may be used on lightwall steel, stainless steel, aluminum pipe or tubing, according to maker. — *Victaulic Co of America, 1100 Morris Ave, Union, N.J.*

Fittings for Teflon hose

205 • Reusable fitting is designed for use with high-temperature Teflon hose. Triple-locking feature is said to lock fittings to hose, components to each other so that assembly cannot loosen from vibration. Lock can be inspected before completing assembly. Fitting blow-offs cannot occur, maker claims. Two seals designed into fittings are dynamically actuated by internal pressure and are positive so that leakage is impossible, according to manufacturer. — *Resistoflex Corp, Roseland, N. J.*

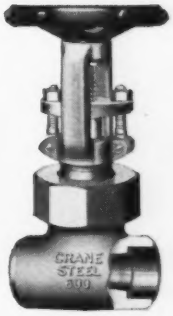
When specifications say "Welded Piping" get everything for the job from CRANE

It is far more satisfactory to get *all* your welding piping materials . . . fittings, flanges, valves, nipples, pipe... from *one* source—CRANE.

Then you're sure of uniform quality. Whether the product is a simple fitting or 24-inch high-pressure, high-temperature valves, Crane controls quality—from raw materials to the finished product.

Each welding type fitting, flange or valve you get from Crane is produced and inspected to established standards—assuring uniform size, wall thickness, and dimensional accuracy—for a good welding job.

One source of supply—from Crane—simplifies ordering, bookkeeping and stock-keeping. Prompt delivery service can be had from Crane's 141 branches, or from wholesalers who serve all areas.



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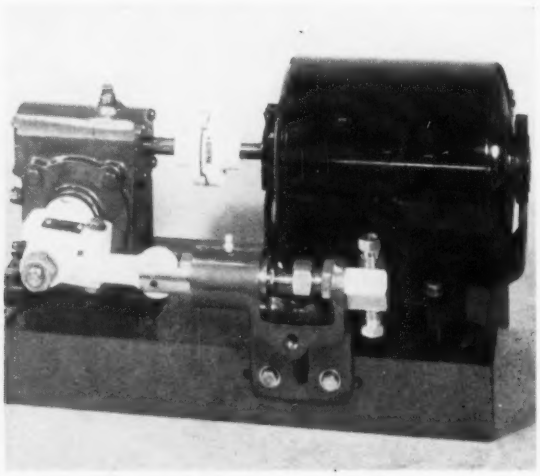
Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

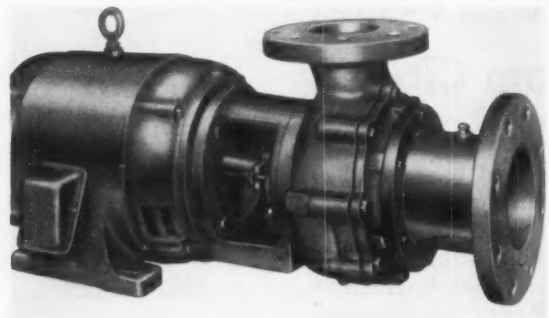
All-aluminum pump comes in two sizes

206 • Self-priming pump for construction, utility application weighs 49¾ lb in 1½-in. size, 52½ lb in 2-in. size. Self-lubricating mechanical shaft seal is said to eliminate leakage. Improved diffuser system permits rapid priming with minimum of water in pump case, according to manufacturer. Cover plate may be removed quickly for inspection; tapped holes for vacuum and pressure gages and drain plug are included. Thumb-screw filler plug permits rapid filling.—*Marlow Pumps, Div of Bell & Gossett Company, Midland Park, N. J.*



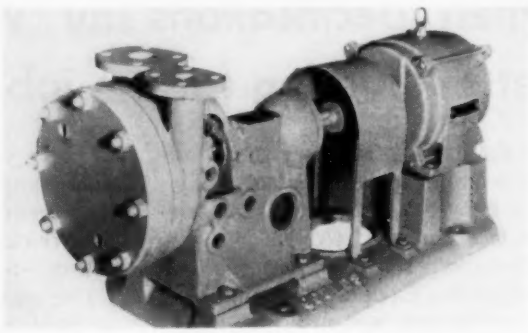
Metering pump gives laboratory accuracy

207 • Controlled-volume unit handles flow rates up to 7880 ml per hr, pressures to 1000 psi. Constructed with motor-drive action on plunger for suction as well as discharge strokes, pump is said to have repetitive accuracy of 1% of full capacity. Applications include metering hydrazine into boiler feedwater. Pumps are driven by 1/3-hp single-phase 60-cycle 115-v motors; may have single or duplex liquid ends made of plastic, stainless steel or Hastelloy *C.—Milton Roy Co, 1300 E Mermaid Lane, Philadelphia 18, Pa.*



General-purpose pump has end suction

208 • Unit comes in close-coupled and pedestal-mounted horizontal, flange-mounted and base-mounted vertical models. Sizes range from ¼ to 40 hp at 3500 rpm, ¼ to 20 hp at 1750 rpm. Designed for circulating, coolant, cooling-tower application, pumps are said to have low NPSH characteristics to meet critical suction conditions. Interchangeable inserts give quick packing-to-seal changeover.—*Aurora Pump Div, New York Air Brake Co, 47 Loucks St, Aurora, Ill.*

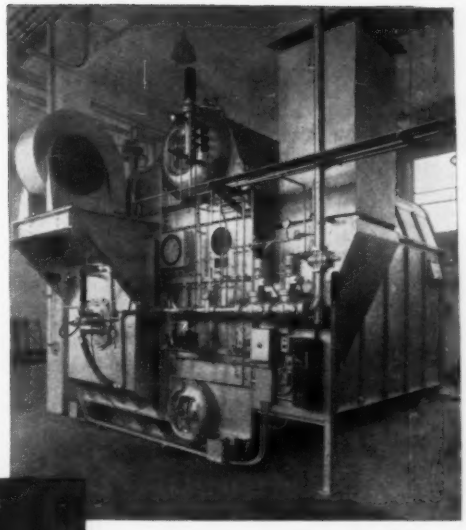


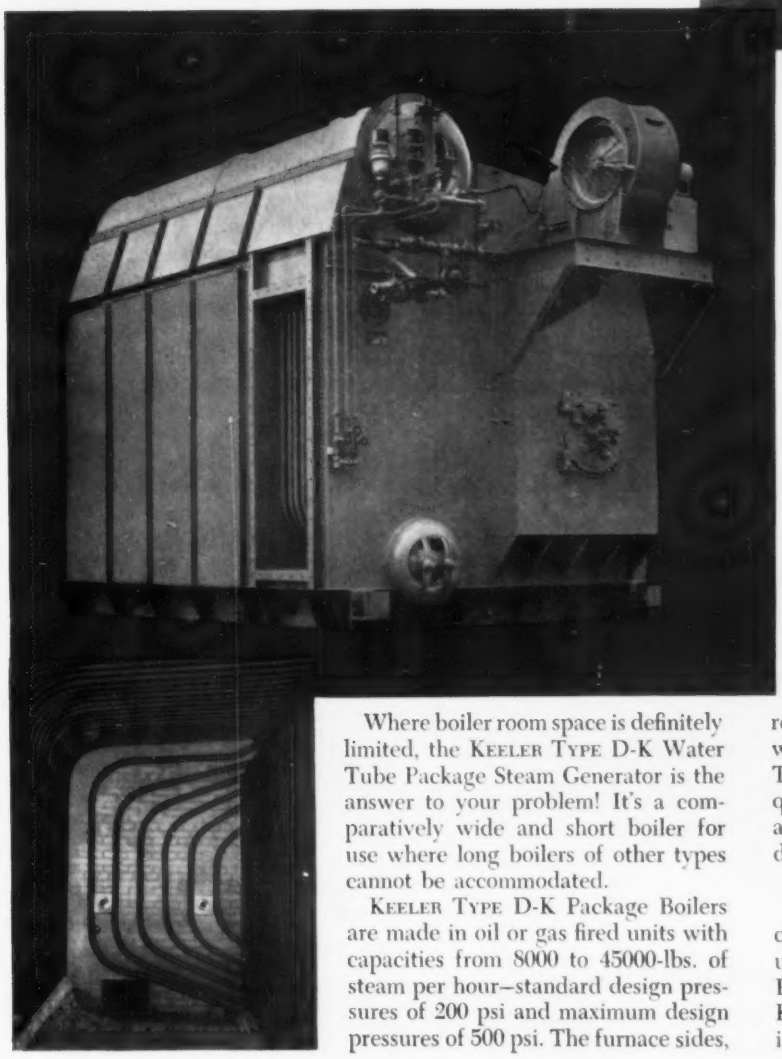
Steam jacketing added to chemical pumps

209 • Jacketing comes on all sizes and constructions of fig. 3715 pumps for steam pressures to 100 psig or 338 F saturated steam, is made of fabricated steel, asbestos gasketed, bolted to remachined casing cover. Savings in power, process water or product result from raised temperature, maker claims. Jackets permit use for handling aqueous salt solutions, prevent precipitation and attendant clogging and seal damage.—*Goulds Pumps, Inc, Seneca Falls, N.Y.*

For more data on these items, use post cards on page 163. Identify your request with item number

packaged power for limited space requirements . . .





KEELER

Type D-K

a comparatively wide and short boiler incorporating the proven efficiency and economy of Keeler Water Tube Steam Generators in a compact, low cost unit

Where boiler room space is definitely limited, the KEELER TYPE D-K Water Tube Package Steam Generator is the answer to your problem! It's a comparatively wide and short boiler for use where long boilers of other types cannot be accommodated.

KEELER TYPE D-K Package Boilers are made in oil or gas fired units with capacities from 8000 to 45000-lbs. of steam per hour—standard design pressures of 200 psi and maximum design pressures of 500 psi. The furnace sides, roof and floor, as well as front and rear walls, are water cooled and insulated. The complete "package", ready for quick hook-up and operation, includes all burning equipment, controls, safety devices and accessories.

For a low first cost, low operating cost outfit, you'll want the full particulars on this compact Package Power Plant! Write or phone . . . there's a KEELER representative at your service in your locality.

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No. DK-1: Type DK Package Boilers
No. F-14: Type CP Package Boilers
No. M-2A: Type CPM Package Boilers
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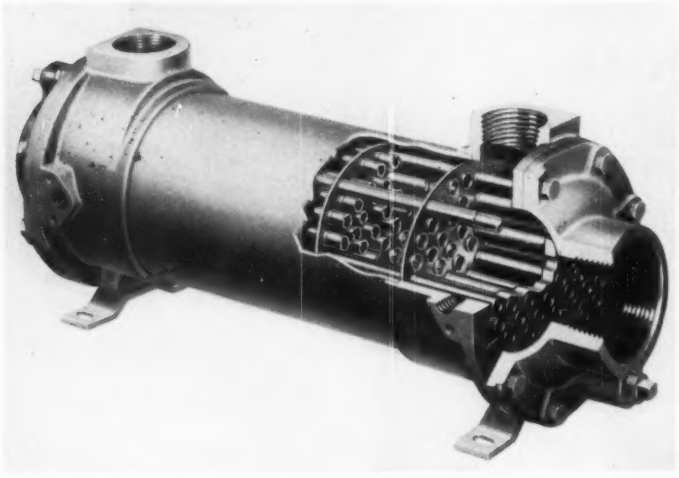
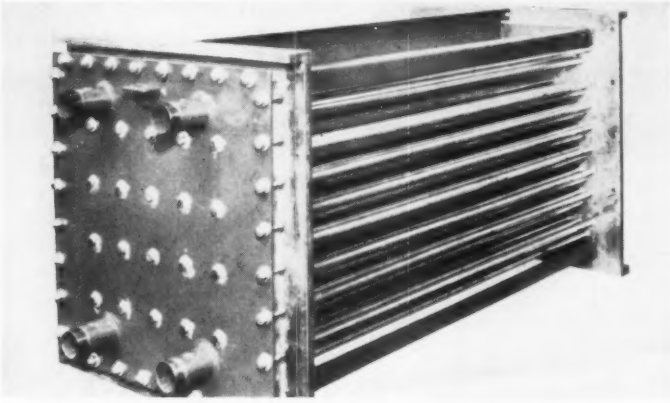
KEELER WATER TUBE Boilers



Redesigned exchanger comes in 46 sizes

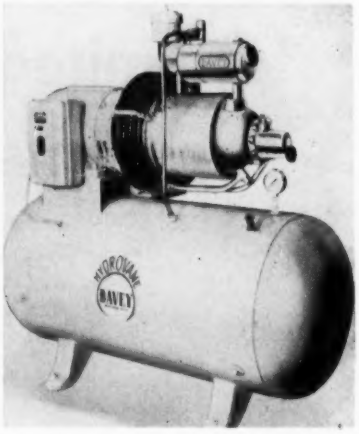
210 • Heat exchanger is now available in one-, two- and four-pass designs, with 1.2 to 124 sq ft of heat-transfer surface. Designed for cooling lube oil, jacket water, hydraulic and other fluids, as well as process heating applications, unit is fully pre-engineered.

Features are said to be: baffle structure with flanged lip at each tube hole and around outer edge for tighter tube fit and improved thermal characteristics; stamped steel feet movable in three positions; corrosion-resistant copper-alloy core assembly.—*Ross Heat Exchanger Div of American-Standard, Buffalo 5, N. Y.*



Coils perform various exchanger duties

211 • Designed for process-industry application, coils are manufactured in prime-surface and extended-surface types. Metals available include aluminum; copper; stainless, carbon and alloy steels; hot-dipped galvanized steel. Types include series flow, serpentine coils, parallel-flow coils with special headers, fully cleanable coils, variously partitioned coils, and coils with bends to various radii. Pressures up to 3000 lb are available, according to the manufacturer.—*Niagara Blower Co, 405 Lexington Ave, New York 17, N. Y.*



Tank-mounted compressor

212 • Rotary-unit line comes in 2-3 and 5 hp models operating at 100 and 200 psi. Features include freedom from vibration, quiet operation, easy installation with no special compressor room required. Designed for general industrial applications, units are said to be up to 60% smaller.—*Industrial Div, Davey Compressor Co, Kent, Ohio.*

Booster-compressor combo

213 • Booster and second-stage compressor unit has nine 4¼-in. stroke cylinders, six with 4⅜-in. bore, three with 3½-in. bore. Intercooler is inserted between two stages. The unit is designed for low-temperature work with minimum equipment. Speeds are said to range up to 900 rpm.—*Frick Co, Waynesboro, Pa.*

For more details on these items use post cards p 163. Identify your request with item number.

Maybe *you'll soon have this decision to make*

LUBRICATION CASE STORY ON THE NEW WORTHINGTON AT INDEPENDENCE, IOWA

Situation: Gene Williamson, plant superintendent, had a decision to make when the Independence, Iowa, Municipal Light Plant installed a new 3600 Horsepower Dual-Fuel Worthington last year. What lubricating oil to use? Other equipment in the plant was lubricated with STANODIESEL Oil M. Performance was excellent. Lubrication technical service performed by men with experience and training for the job likewise was excellent.

What was done: The decision was made to install STANODIESEL Oil M. Now after 3,780 hours of operation, there are no regrets. There are no signs of wear.

STANODIESEL Oil M is refined from the finest-quality base stock. Additives help the oil resist viscosity change, keep engine parts clean. Other additives control foam, make it possible for oil to reach and hold protective film on even the most difficult to lubricate parts.

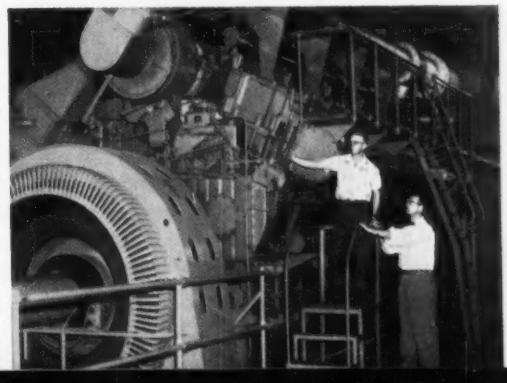
What you can do: Get all the facts about STANODIESEL Oil M from your Standard Oil lubrication specialist. There's one near you in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

Quick facts about

STANODIESEL OIL M

- Keeps crankcase, pistons, cylinder walls clean.
- Combats deposit and wear problems imposed by use of economy fuels.
- Maintains film on difficult to lubricate parts.
- Eliminates fuel injector and pump sticking caused by deposits on injector barrel and plunger where fuel and lube oil mix.

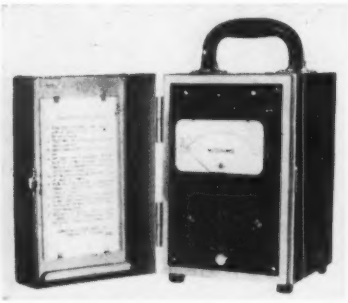
You expect more from **STANDARD** *and get it!*



Running smoothly. Gene Williamson, power plant superintendent, and Standard Oil's Bob Wenger (right) check over new Worthington Dual-Fuel engine. Good lubrication technical service is one of the reasons Williamson decided upon STANODIESEL Oil M when engine was installed. Bob Wenger is well qualified by both experience and training to provide such technical service. He has been doing this work for nine years. In addition, he has an engineering degree from Iowa State and has completed the Standard Oil Sales Engineering School.

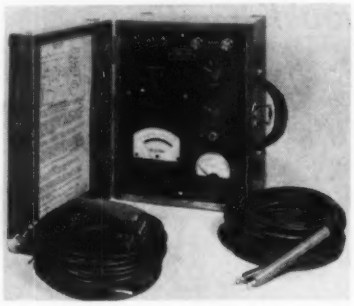
More **equipment news**

Begins on page 156



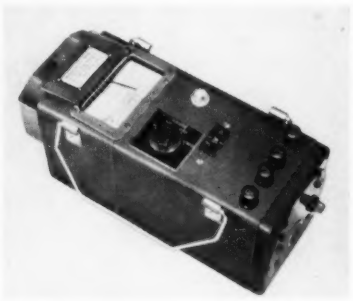
Megohm insulation tester

214 • Insulation - resistance tester measures accurately from 1 to 50,000 megohms, maker claims. Meter has four overlapping ranges, with center scale values of 2, 20, 200 and 2000 megohms. Circuit design, said to assure calibration, employs standard tubes and a meter tracking control for easy matching of meter, metering circuit with original accuracy when tube is replaced. Unit has regulated 500-v test potential.—*Associated Research, Inc, 3758 W Belmont St, Chicago 18, Ill.*



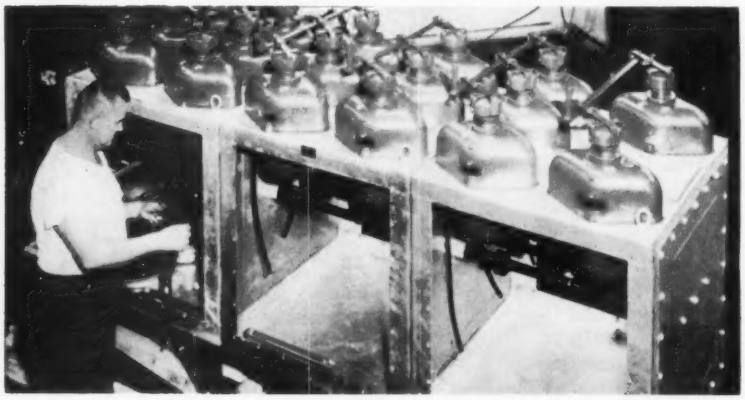
Microhm meter

215 • Unit is designed for making accurate resistance measurements in the microhm range; is said to be a service-type instrument with laboratory accuracy. Reads directly in microhms on 0-75 range; a selector-switch cuts in multipliers for four additional ranges. Meter checks oil and air circuit breaker contacts without disassembly, limiters, windings in transformers and rotating equipment. Uses "core-magnet" type indicators.—*J W Dice Co, 16 Highwood Ave, Englewood, N. J.*



Low-resistance ohmmeter

216 • Direct-reading unit measures down to 10 microhms, has four ranges: x1, x10, x100 and x1000. Instrument with leads and prods weighs 10 lb; case is 13 x 6 x 7 in. Applications in electrical maintenance include resistance measurements of electrical conductors, joints, contacts and windings in oil circuit-breaker assemblies, rotating equipment, transformers and coils. Unit comes with battery or rectifier, and an automatic circuit breaker. — *James G Biddle Co, 1316 Arch St, Philadelphia 7, Pa.*



Oil-cutout assembly is metal enclosed

217 • Unit is said to provide economic switching and protection of heavy industrial branch circuits. Assemblies are installed in parallel at plant's feeder line switch, one for each two branch circuits. Cutouts, single-phase or gang-operated three-phase, are mounted on top of box. Feeder bus runs, connections, heater element to dispel moisture are completely encased. Expansion requirements can be met by adding more boxes.—*General Electric Co, Distribution Transformer Dept, Pittsfield, Mass.*

Don't miss this item . . .

Portable pipewall gage . . p 168

. . . or other product news appearing on following pages

Submersible pump . . . . . p 168
General-purpose 'scope . . . p 170
Redesigned potentiometer p 170
Panel coils . . . . . p 172
Automatic screwdriver . . . p 172
Nonsegregated phase bus p 174
Ground detector—alarm . . p 174
All-plastic strainer . . . . . p 176
Portable desk . . . . . p 176

For more data on these items, use post cards on page 163. Identify request with item number

Keep yourself up to date . . .

To get more info on new equipment or FREE copies of latest bulletins

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ELECTRICAL, MECHANICAL CONTROLS

1 **Voltage regulators** are discussed in 28-p illustrated booklet 5.00.2. Gives case histories, application data, descriptions and specs. Electric Regulator Corp, Pearl St, Norwalk, Conn.

2 **Precision limit switch** that can be replaced in seconds is subject of 4-p bulletin 20. Drawings, photos of five actuator types are included. Micro Switch, Div of Minneapolis-Honeywell Regulator Co, Freeport, Ill.

3 **Electrical controls,** all-purpose type, are discussed in 12-p bulletin 106. Contains application info, photos, diagrams and specs. Assembly Products, Inc, Chesterland, Ohio.

ELECTRICAL EQUIPMENT

4 **Substation structures** made of aluminum are subject of 48-p brochure. Gives design info, charts and diagrams, ASCE specs, cost analysis data. Kaiser Aluminum & Chemical Sales, Inc, 919 N Michigan Ave, Chicago 11, Ill.

5 **Low-voltage switchgear** is discussed in 20-p bulletin 6004-C. Units from 225 to 4000 amp are illustrated. Includes dimensions, graphs. I-T-E Circuit Breaker Co, Switchgear Div, 19th & Hamilton Sts, Philadelphia 30, Pa.

6 **Synchronous motors,** high-speed type, are described in 8-p bulletin GEA-6620. X-ray views of units up to 1500-hp are included. General Electric Co, Schenectady 5, N. Y.

7 **Transformer engineering** is 12-p manual 137. Treats four series of dry-type distribution units. Diagrams, specs for 3 to 500 kva units are included. R E Uptegraff Mfg Co, Scottdale, Pa.

8 **Ac motors,** 1 to 125 hp, are discussed in 4-p bulletin B-2506. Describes and illustrates totally protected units and modifications. Reliance Electric & Engineering Co, 24701 Euclid Ave, Cleveland 17, Ohio.

MAINTENANCE EQUIPMENT, MATERIALS

9 **Sheet packings** for industry are discussed in 8-p illustrated bulletin P-328. Gives specs and engineering, application and testing data on 19 varieties. Crane Packing Co, Dept PRN, 6400 Oakton St, Morton Grove, Ill.

10 **Brush plating** with the Dalic process is described in 12-p booklet. Applications discussed include cold welding, resizing, precision fitting. Marlane Development Co, 153 E 26th St, New York 10, N. Y.

MATERIALS HANDLING

11 **Loading assembly** is subject of 4-p bulletin F-41. Describes spring-balanced, slide-sleeve loading assembly (*Continued on page* 218)

POWELL

world's largest family of valves

Fig. 19084—Steel Pressure Seal Globe Non-return Valve for 900 W.S.P. Spur Gear operated. Can be furnished with bevel gears.

Fig. 6003 WE—Steel O.S. & Y. Welding End Gate Valve for high pressure service—600 W.S.P. Steel valves are available for pressure from 150 to 2500 W.S.P.

Fig. 1793—Iron Body Bronze Mounted O.S.&Y. Gate Valve for 125 W.S.P. Solid wedge disc. Sizes under 8" can be supplied with double wedge disc.

Fig. 3061 WE—Steel Welding End Swing Check Valve for 300 W.S.P. No obstruction to flow through when wide open.

Fig. 375—Bronze Gate Valve for 200 W.S.P. Union bonnet, inside screw rising stem. Renewable nickel-bronze solid or double wedge disc.

Fig. 125023—Large Steel Pressure Seal Gate Valve for 2500 W.S.P. Equipped with Electric Motor for operation by remote control. Steel Pressure Seal Valves can be furnished for pressures from 600 through 2500 pounds.

FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

George Edwards

says, "Ol' rockin' chair got you? Listen!"

How often have you heard a guy say "I'll believe it when I see it," or words to that effect, then in the next breath tell you what he's got on the fire for the next week end, or where he's going fishing next summer?

With his first statement, he wants you to know that he's a practical guy—a realist—who won't buy any deal unless it's sure-fire. Then he turns around and pulls the rug from under his "hard-facts" standards. For if, as he claims, taking anything on *faith* is for the birds, how the heck can he depend on his personal air castles?

It boils down to the fact that faith in *something* is a big part of our lives whether we like it or not. If we don't recognize it, or won't admit it, we're going through life in low gear so far as real pleasure is concerned.

There are plenty of success stories in which faith —always backed up by hard work—is the chief ingredient. Some are outstanding because of the from-poor-newsboy-to-rich-and-prominent-citizen theme. But there are lots of other guys—Horatio Alger probably wouldn't have given any of them a second look—who might easily be called the unsung heroes in the struggle to build a better life for themselves—and for all of us.

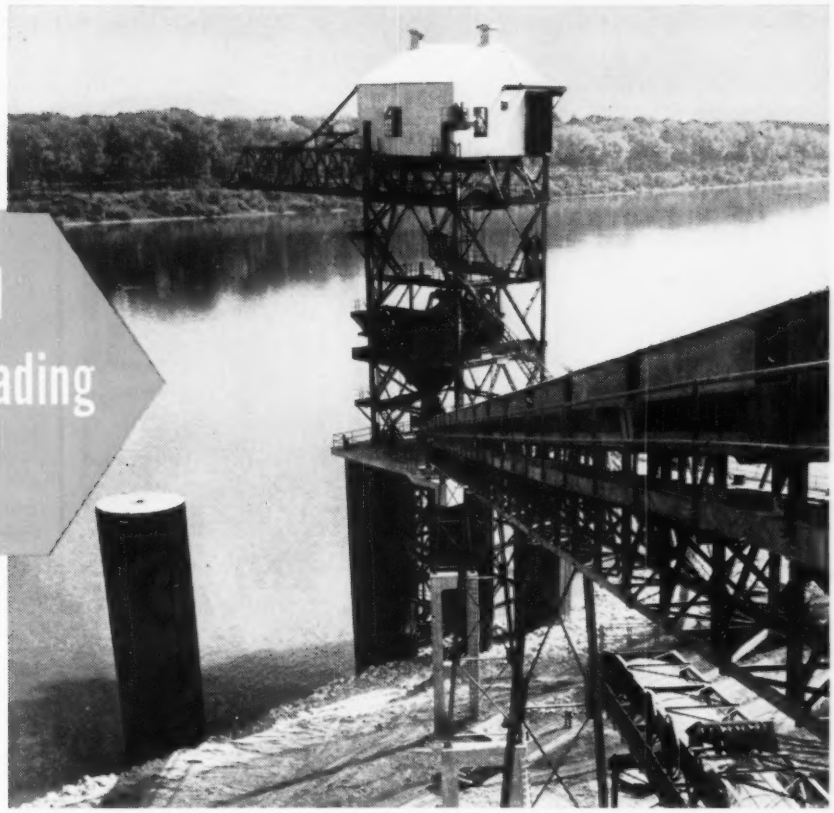
Typical of these is the man whose picture you see at the top of the page. His name is Elijah Williams and he was 82 years old last October. Now it isn't unusual these days for a man to live to be this age. But Mr Williams, at 82, is busy running his boiler shop in New Haven, Conn. What's more, his crew celebrated his birthday by assembling the first unit of a wet-back Scotch marine boiler design recently developed by none other than Elijah Williams. In telling me about it with justifiable pride, Mr Williams said, "This design, with no through stays or head to shell braces, will revolutionize the old hrt."

Born in Staffordshire, England, Mr Williams came to the U.S. as a young man and got a job as a boilermaker apprentice at $8.10 for a 50-hr week. After working up to superintendent of erection for a major boiler manufacturer, he started his own boiler shop. Eager to learn down through the years, Mr Williams told me "I studied all the books and magazines I could find, including POWER which I took until last year when I had to give it up on account of my failing eyesight."

Beside repairing all sorts of boilers and unfired pressure vessels, and building new ones according to purchasers' specs, Mr Williams spent a lot of time in dreaming up ways to build better units. And he's still at it—at an age when most people are inclined to sit around and talk of old times. I think it's wonderful.

Elijah Williams probably hasn't done a thing that anyone else couldn't have done. He didn't get the "breaks" that people like to mention as an excuse for the other guy's success and their own lack of it. But I think he'd tell you mighty quick that *faith* has been responsible for the fun and satisfaction he got and is still getting out of life; faith in himself and in what constructive thinking can produce—and being willing to do some real digging along with his dreaming.

The Last Word in Barge Unloading Equipment!



The 6th H&P high-capacity rope trolley barge unloader located on the Ohio River is in its final stages of erection. Like the others, the complete job was done by Heyl & Patterson—*from design to erection.*

In the picture you can notice the "unusually high" lift (105 ft. average), the arrangement of the 2500 ft. bucket cable reels, permitting continuous reeving (i.e. easy replacement of worn rope and lower rope cost per ton of material handled), the 5 ton electric hoist and lift beam for ready installation of these cable reels, and the bucket buggy for convenient and fast changing of buckets.

The rope trolley motions are controlled by an adjustable voltage system; a guided counterweight is provided for economical operation of the 12-ton bucket, which is equipped with a counterweighted tagline to prevent twisting, and good visibility is provided in the operator's cab to easily observe bucket and barge haul operations. The barge haul will be mounted on a floating dock.

For further information on all types of bulk material handling equipment, contact your H & P Contracting Engineer.

- Barge and Boat Unloaders
- Coal Handling Equipment
- Coal Storage Bridges
- Rotary Car Dumpers
- Thorsten Coal Samplers
- Bradford Coal Breakers

When Experience Counts...
Count on Heyl & Patterson

Heyl & Patterson INC.

55 FORT PITT BLVD. • PITTSBURGH 22, PA.
PHONE COurt 1-0750

W&T V-notch Chlorinator installed at Esso's Baton Rouge Refinery feeds chlorine at rates up to 500 lbs./24 hr. Units are available with chlorine capacities up to 2000 lbs./24 hr.

NEW W&T V-NOTCH CHLORINATORS,

used at Oil Refineries, are rugged, easy to operate and moderately priced.

Esso Standard Oil Co. has a W&T V-notch Chlorinator installed at their Baton Rouge, La., Refinery. The chlorinator, installed in a small shed open to the sun and weather, chlorinates cooling water for slime control.

This type of installation would be considered rugged service for other equipment but V-notch Chlorinators are designed for such use. They are made of materials that are completely resistant to corrosion as well as weather. They are simple to operate and to maintain. In addition, W&T V-notch Chlorinators are an attractive piece of equipment, colored green to fit into industrial color schemes.

For more information about W&T V-notch Chlorinators, send for bulletin CD-44.

WALLACE & TIERNAN INCORPORATED

25 MAIN STREET, BELLEVILLE 9, NEW JERSEY

ELECTRO RUST-PROOFING

CORPORATION

30 MAIN STREET, BELLEVILLE 9, N. J.

Equipment news

Begins on page 156

Portable pipewall gage

245 • Completely transistorized, portable unit weighs 7½ lb, is used to measure absolute pipewall thickness directly on pipes ranging from 2 to 8 in. nominal in diameter. Principle of radiation absorption is used, so nonferrous and plastic piping may be measured. Reproducibility and resolution of better than 0.010 in. are achieved in pipewalls from 0- to 1-in. thick. — *Industrial Nucleonics Corp, 1205 Chesapeake Ave, Columbus 12, Ohio.*

For more details on these items, use post cards p 163. Identify your request with item number.

Submersible pump

239 • Portable unit is said to function effectively on heavy-duty water-pumping operations where dirt, grit or other solids are contained in the water. Unit can handle to 20% solids.

Pump is adapted for filter-screen sump service and supplying river-water intake for industrial plants. It operates partly or completely submerged. Built-in thermostatic cutoff

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Flexitallic Blue is a positive means of gasket identification.

The blue dye in the Canadian asbestos filler tells an engineer that this is a genuine Flexitallic Spiral-Wound Gasket, made to just one standard of quality since 1912.

Flexitallic Gaskets are exclusively spiral-wound. Constructed to meet specific conditions of thermal and mechanical shock, vibration, weaving and other joint stresses.

The high safety factor of Flexitallic Gaskets results from two unique characteristics — compression response of the gasket is directly related to bolting for each application; exacting mechanical controls assure that manufactured gaskets conform to specification.

Whenever you are confining fluids in a critical pressure/temperature range, insist on Flexitallic Spiral-Wound Gaskets. Look for Flexitallic Blue.

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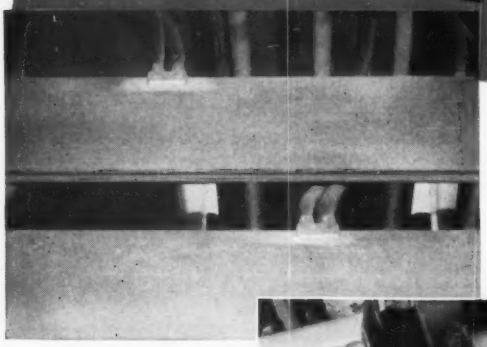
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

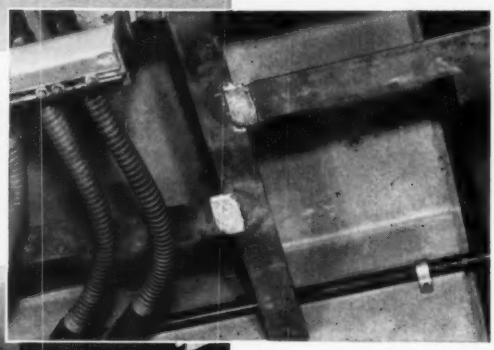
* Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler

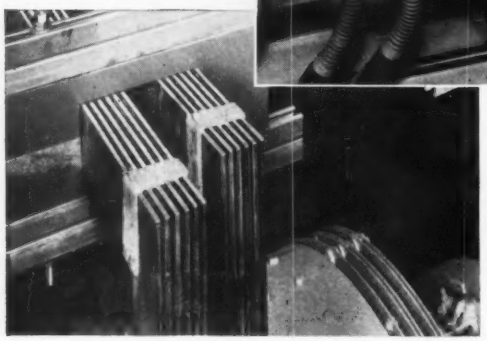
BUS CONNECTIONS BEST with CADWELD®



Cable Taps to Bus Bar

Bus Bar Taps to Bus Bar





Multiple Bus Bar Connections

When making electrical connections to bus bar, CADWELD is best. 100% electrical current carrying capacity of the conductors is obtained every time. Plus every connection is permanent, there is no loosening or corrosion.

90% of the possible connections are standard and the remaining 10% (specials) can be handled in record time.

The finished CADWELD connection is more compact than any mechanical connection on the market.

CADWELD Electrical Connections have attained their high rating from Engineers and Contractors for their reliability. There is no maintenance on a CADWELD Connection.

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Erico Products, Inc.

2070 E. 61st Place Cleveland 3, Ohio

IN CANADA: ERICO INCORPORATED, 3571 Dundas St., West, Toronto 9, Ontario

Equipment news

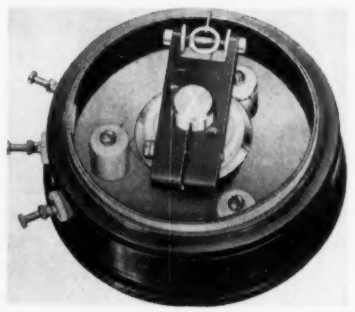
Begins on page 156

protects motor against damage from overheating. Automatic reset starts pump when obstructions are removed. Squirrel-cage 3-phase 6-cycle motor is rated 7½ hp, operates in factory-sealed oil bath. Weight: 238 lb.—*Sumo Pumps Inc, 23 Brown House Rd, Stamford, Conn.*

General-purpose 'scope

241 • Oscilloscope unit measures 8 x 12¼ x 16½ in. Unit features 5-in. screen, filter-type graticule and universal-fit bezel. Applications include industrial maintenance and production testing.—*Simpson Electric Co, 5200 W Kinzie St, Chicago 44, Ill.*

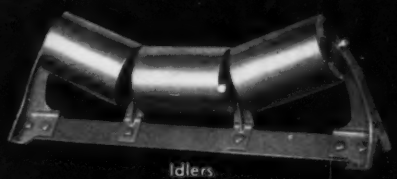
For more details on these items, use post cards p 163. Identify your request with item number.



Redesigned potentiometer

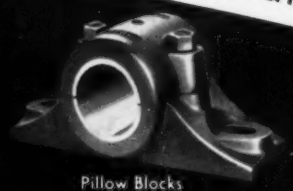
227 • Dynamic balance is said to be new principle in potentiometer design, providing mechanical performance to match electronic precision. Concept centers around contact: arm

Couplings



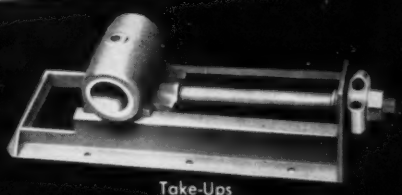
Idlers

for all your elevating and conveying machinery...



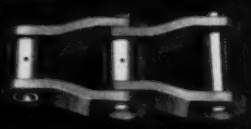
Pillow Blocks

JEFFREY equipment and accessories



Take-Ups

Chain for Drives, Elevating and Conveying



Sprocket Wheels

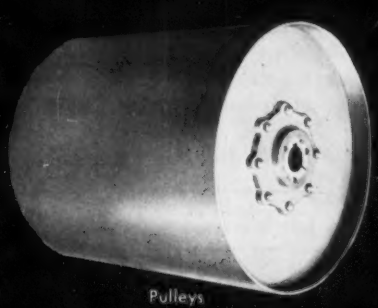
Discharge Valves

● Check the Jeffrey line when specifying parts or accessories for any of your materials handling jobs. Jeffrey products have been time-tested on original equipment and as replacements in all kinds of industrial applications. Their design, materials and workmanship are of the finest, assuring efficient, low-cost service.

Jeffrey transmission products are widely known for quality and dependability. Many of the most popular types of chain were originated and patented by Jeffrey and since have been adopted as standard throughout industry. Send for complete data. Distributors in principal cities. The Jeffrey Manufacturing Company, 932 North Fourth Street, Columbus 16, Ohio.

JEFFREY

CONVEYING • PROCESSING • MINING EQUIPMENT...
TRANSMISSION MACHINERY...
CONTRACT MANUFACTURING

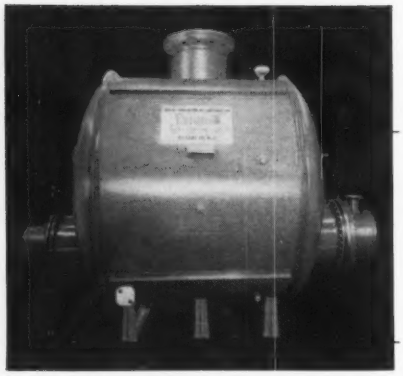


Pulleys

Buckets

Spiral Flights

Paracoil EVAPORATORS



Paracoil Makeup Feed Water Evaporator now serving the City of Columbia, Missouri power plant. Consulting Engineers, Lutz and May, Kansas City, Missouri. Rated at 6,000 lbs. of steam per hour at 30 psia, with carry-over not exceeding 1 PPM. Built to ASME code requirements.

creatively engineered by Davis for installation in numerous public and private power plants

Davis Engineered Features

- All tubes and rolled tube joints can be hydrostatically tested without removing tube bundle.
- Tube bundle, with outside packed floating head, has free movement to allow for expansion and contraction.
- Any tube can be replaced without disturbing adjacent tubes.
- No internal steam connection or blind gasketed joints.
- Removable tube bundle.
- Pitched tube bundle to provide for complete drainage of condensate.
- Tubes arranged on wide square pitch to facilitate mechanical cleaning.
- Straight tubes of equal length to simplify tube stocking.
- Single-pass tube bundle for maximum free flow area of steam in tubes and minimum pressure drop through tube bundle.

Paracoil Evaporator Installations include the following:

Puerto Rico Water Resources Authority
Consulting Engineers: Jackson & Moreland, Boston, Massachusetts

Borough of Wellington, Connecticut
Alabama Electric Cooperative, Inc., Andalusia, Alabama
Consulting Engineers: Burns & McDonnell, Kansas City, Missouri

Western Electric Cooperative, Inc., Andarko, Oklahoma
Consulting Engineers: Laramore & Douglass, Inc., Chicago, Illinois

City of Bryan, Texas
City of Lafayette, Louisiana
Consumer's Public Power District, Ogallala, Nebraska
Consulting Engineers: Lutz and May, Kansas City, Missouri

Davis Makes it — Better! **Write for Bulletin 1000**

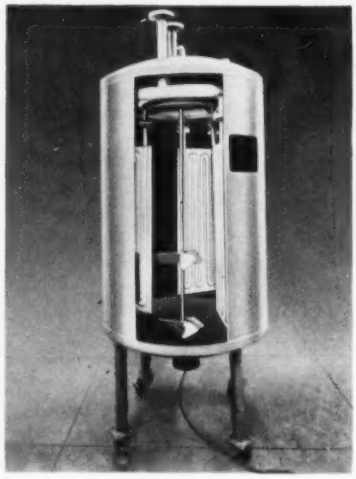
DAVIS ENGINEERING CORPORATION
30 Rockefeller Plaza, New York 20, New York • Circle 6-5650

Equipment news

Begins on page 156

is rigidly clamped and balanced with respect to shaft, contact assembly is mounted in jeweled pivots and balanced with respect to arm, so only light spring pressure is needed to assure contact with winding. Maximum allowable rotational speed, life expectancy and long-term accuracy are all improved, according to manufacturer.

Unit comes in six sizes, 7/8 to 3 in. Mechanical rotation is 360 deg continuous, with phaseable stops available. Operation to 165 C is standard. Unit has metal housings, ceramic and Teflon interiors, silicone-glass laminate winding card. —*Electronic Div, Chicago Aerial Industries, 10265 Franklin Ave, Franklin Park, Ill.*



Panel coils

255 • Panel coils are said to provide efficient, economical heat transfer. Units are easily removed and replaced for maintenance; smooth surface requires little cleaning, according to manufacturer. Reactor fitted with *Thermo-panel* units allows relatively large volume within tank combined with large heating and cooling surface.—*Dean Thermo-Panel Coil Div, Dean Products, Inc, 616 Franklin Ave, Brooklyn 38, N. Y.*

For more details on these items, use post cards p 163. Identify your request with item number.

Automatic screwdriver

228 • Unit automatically feeds and drives standard socket setscrews at rates up to 1800 per hr. It handles

Wide Size Range . . . in Any Quantity . . .
Builds UTILITY Demand for
B&W HOLLOW FORGINGS

Leading electric utilities—like American Gas and Electric, Carolina Power & Light, Commonwealth Edison, and Wisconsin Electric Power—use B&W hollow forgings for main steam, reheater, feedwater, and similar lines. B&W hollow forgings give them a sound solution to their piping problems.

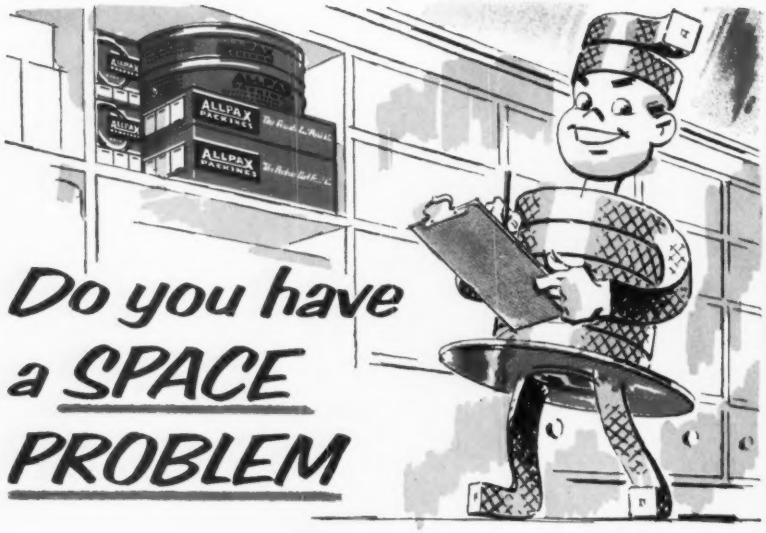
These heavy-duty forgings can be specified to exact design requirements. They are made from high quality carbon, alloy, and stainless steels. They are produced with vigilant care under controlled conditions from the initial melt through final inspection. That's why B&W hollow forgings give users savings in time and money.

For additional information, write for Bulletin S-16. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

Ask for this Bulletin: S-16

BABCOCK & WILCOX
BOILER DIVISION

S–473–HF



Do you have a SPACE PROBLEM in your Stockroom?

If your problem is space and inventory, Allpax has the answer. Allpax "Universal" Packings save valuable stockroom space and reduce inventories. Included in the complete line of Allpax mechanical packings are four basic, universal styles that will cover the majority of your requirements. Result: Less inventory required—more stockroom space available.

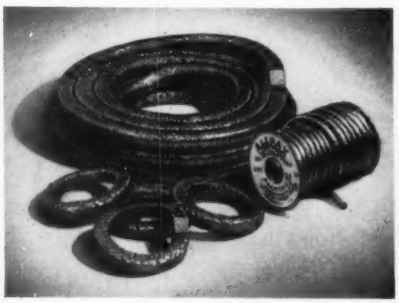
Allpax Styles 1, 2, 5, and 14 are "Packing Insurance" against steam, water, air, chemicals, acids, oils, etc., over a complete range of temperatures and pressures. Finest materials plus engineered construction are combined to produce our unbeatable, all-purpose packings that provide a tight seal without danger of scoring or unnecessary wear. Warranteed to be free from defects in materials and workmanship.

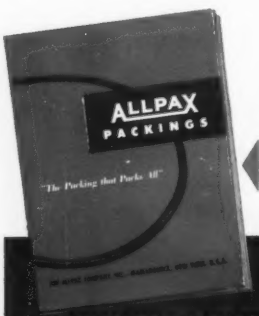
Allpax Universal Packings

- ✔ Save Valuable Space
- ✔ Reduce Inventories
- ✔ Simplify Ordering
- ✔ Reduce Downtime
- ✔ Cut Investment

Also: A complete line of Teflon* packing materials.

*DuPont Trademark





ALLPAX

"The Packing that Packs All"

SEND FOR OUR CATALOG — TODAY!

A complete line of packing, tools, gasket materials
Distributors in principal cities

THE ALLPAX COMPANY, INC.
160 Jefferson Ave., Mamaroneck, N. Y.
CANADIAN DISTRIBUTORS: Albion Asbestos Packings Ltd., Montreal 18, Quebec

Equipment news

Begins on page 156

standard, unmodified socket setscrews in hex or multiple-spline socket types.

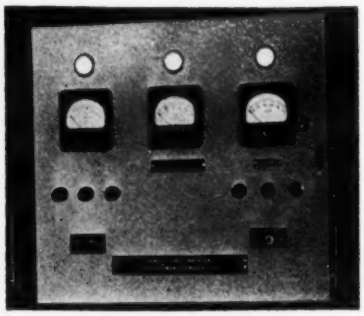
Feeder unit is adapted to modified power screwdriver and uses mechanical rotating-type hopper powered by 1/12-hp motor.—*Socket Screw Div, The Bristol Co, Waterbury 20, Conn.*

Nonsegregated phase bus

233 • Unit is completely sealed with cork neoprene-gasketed split half-round covers, insulated by air and porcelain insulators.

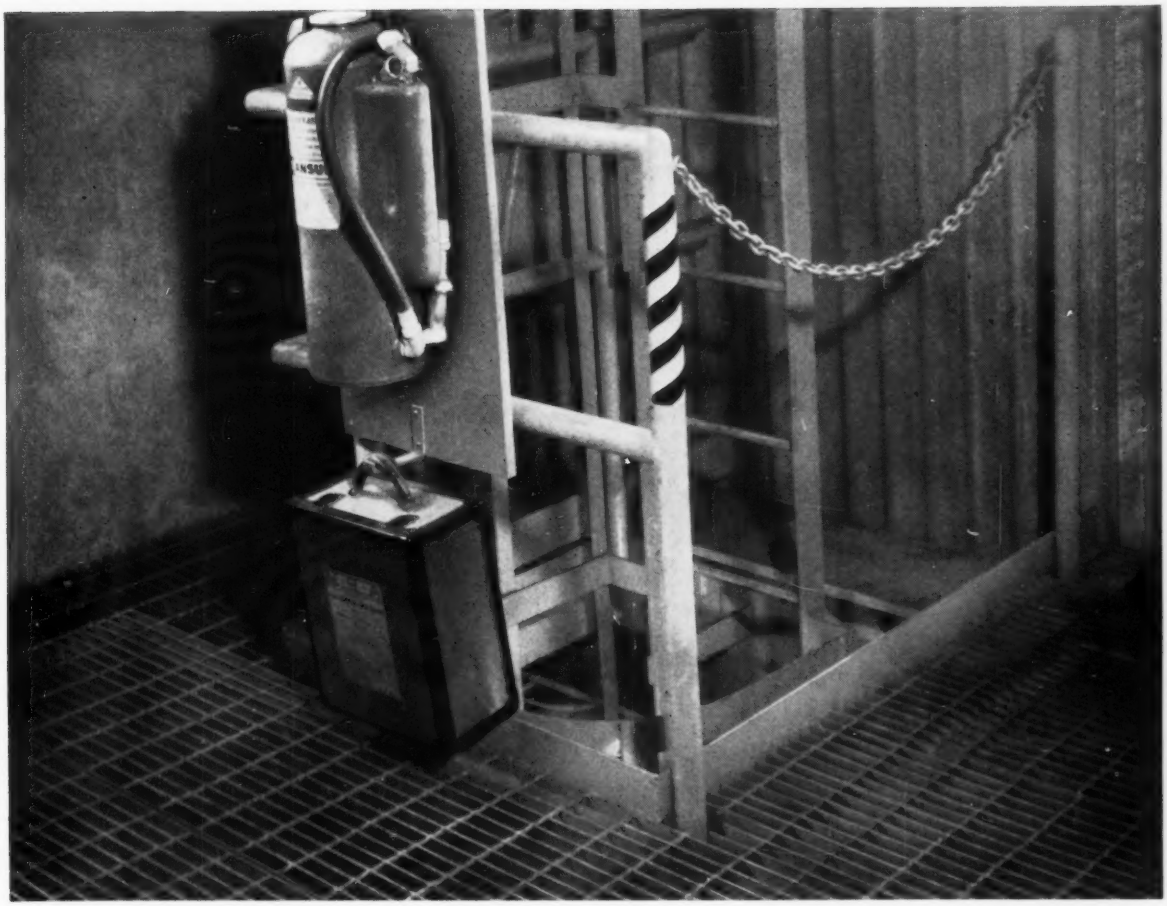
Unit may be used for generator leads to transformers, connecting transformers to switchgear assemblies, interconnecting switchgear assemblies and distribution of light and power in factories and office buildings. Rated 4.16, 7.2 and 13.8 kv, 1200-3000 amp, unit has flexible or laminated connectors for installation ease.—*I-T-E Circuit Breaker Co, 19th & Hamilton Sts, Philadelphia 30, Pa.*

For more details on these items, use post cards p 163. Identify your request with item number.



Ground detector and alarm

236 • Unit is designed to protect personnel and motors on 3-phase power systems. Ground detector is an electrical device with visual and audible alarms to indicate ground



A dangerous place to work...

that's why you see so many symbols of safety

Here's a plant that's out to keep "employee downtime" at a minimum. Extinguishers and gas masks provide protection against fire and toxic fumes. Guard rails and chains surround permanent hazards. Raised steel strips around floor openings prevent objects rolling or being kicked to the floor below. Clean windows and bright lighting provide good visibility. It's only natural that a company so interested in safety should select Blaw-Knox Electroforged® Steel Grating for "underfoot" safety.

Each section of Blaw-Knox Steel Grating is of rigid, one-piece construction. Choice of cross bar and bearing bar designs and spacings affords maximum safety under all working conditions. Indoors or out, you get safe, quiet, long lasting and self-cleaning flooring with maximum passage of light and air.

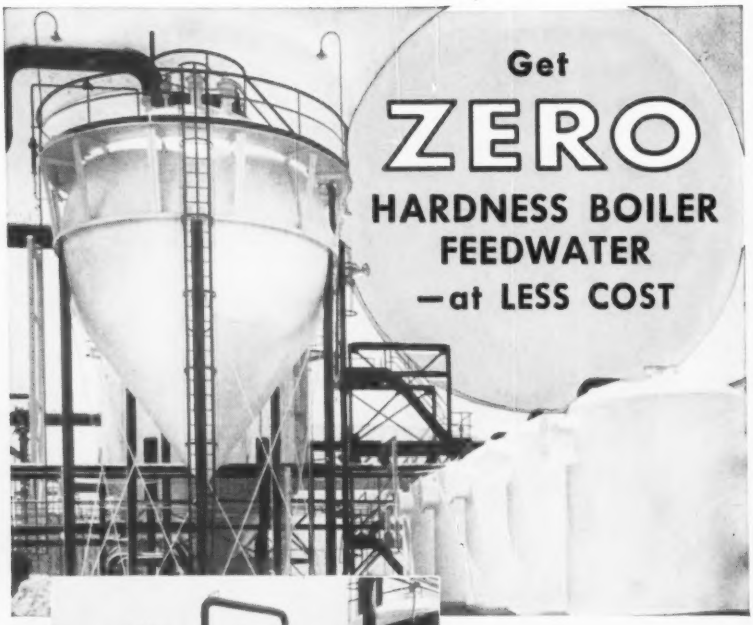
Blaw-Knox Electroforged Steel Grating is fabricated in a wide selection of materials to exact customer specifications. Fits easily and neatly into even the most congested areas.

Send for new Blaw-Knox Grating Catalog 2527. See new ideas in flooring, walkways, stair treads, platforms, shelving. Write today.

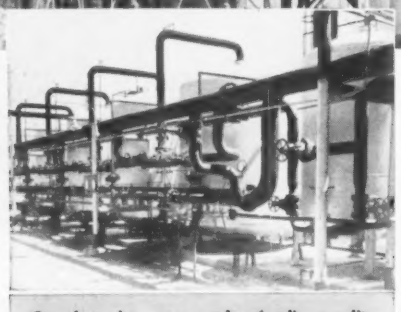
BLAW-KNOX

BLAW-KNOX COMPANY

Blaw-Knox Equipment Division • Dept. Y, Pittsburgh 38, Pa.



Get
ZERO
HARDNESS BOILER FEEDWATER
—at LESS COST



Top photo shows new outdoor hot lime-zeolite softener installation in a Southern refinery. Five Nalcite HCR ion exchange units (lower photo) have output of 470,000 gallons of zero hardness water between regenerations.

with
Nalcite® (DOWEX*) HCR
HOT LIME ZEOLITE TREATMENT

Start with the simplicity of operation . . . add the low operating costs of hot lime-zeolite softening . . . all made possible by the outstanding high-temperature performance of Nalcite HCR in the zeolite softeners. Results: Zero hardness water, from virtually any raw water source, with a minimum of testing and control required. See your water treating equipment manufacturer for details on new or conversion hot lime-zeolite treatment for your plant . . . and for top softener efficiency, specify Nalcite HCR.

*Reg. Trademark of The Dow Chemical Company

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

Nalco® PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

Equipment news

Begins on page 156

faults before they do damage. It can be set to discover line voltage drop of 1 volt in systems of any rating. Unit operates at 110 v, can be installed at any control point. Transformers are included to operate it off the power line.—*Principle Research & Development Co, Box 93, Franklin Park, Ill.*

All-plastic strainer

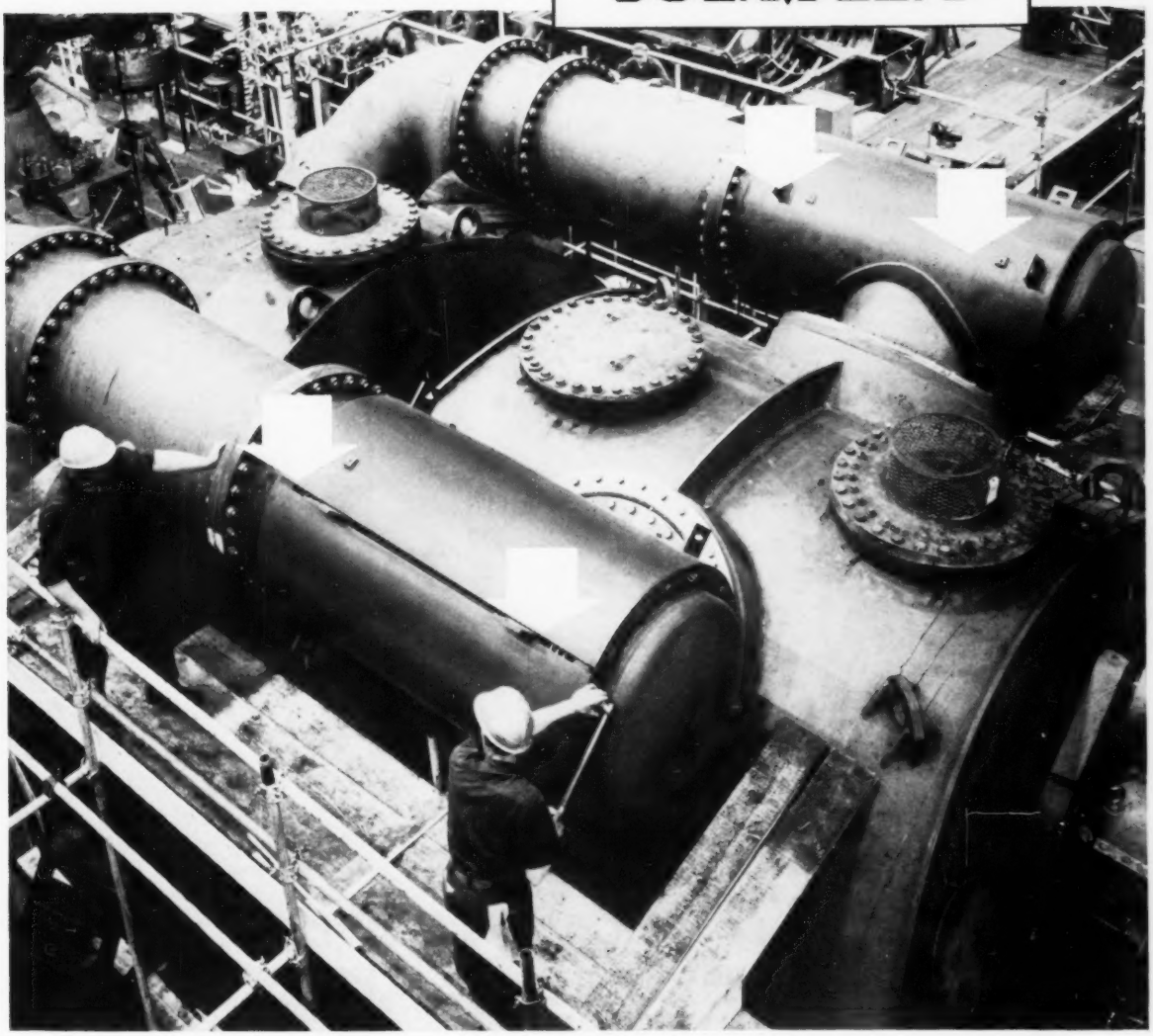
237 • All-plastic Y-sediment unit is made of corrosion-resistant rigid polyvinyl chloride, designed for service on alkalis, acids, inorganic salt solutions. Unit has service rating of 150 psi at 75 F and 75 psi at 150 F. Comes with threaded, solvent-weld socket-type or flanged ends, ½ to 2 in.—*Walworth Co, 60 E 42nd St, New York 17, N. Y.*

For more details on these items, use post cards p 163. Identify your request with item number.

Portable desk

221 • Designed for any phase of industry where accurate record-keeping is necessary, portable desk unit can be mounted on any machine to provide handy writing platform, receptacle for reports and maintenance records. Unit has 1-in. deep basket welded underneath to hold papers. Desk light is optional equipment.—*Product Development Corp, Box 789, Norwalk, Conn.*

Leading firms use **SOLA-FLEX®**



Sola-Flex joints installed on large steam turbine-generator

TWO 36-INCH SOLA-FLEX expansion joints constrain a pressure thrust of 78,000 pounds on this 225,000-kw General Electric steam turbine-generator. These rugged, pressure balanced elbow joints are an important example of why more and more of America's leading businesses—petro-chemical, power, nuclear and others—rely on Sola-Flex bellows and expansion joints to help solve difficult pressure and temperature problems. Solar manufactures the most comprehensive line of bellows and expansion joints in the world. They are made from a wide variety of stainless and high alloys that are *right* for important nuclear, missile and industrial applications—in sizes ranging from ½ in. to 35 feet in diameter. They are built for service from –320 F to 1200 F, and tame "hard-to-handle" pressures up to 3500 psi for special applications.

A new pamphlet describes Solar's complete line of Sola-Flex bellows and expansion joints. Write for it to Dept. D-146, Solar Aircraft Company, San Diego 12, California.

SOLAR AIRCRAFT COMPANY
SAN DIEGO
DES MOINES

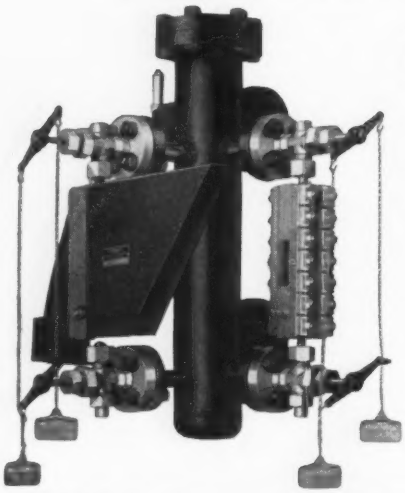
DESIGNERS, DEVELOPERS AND MANUFACTURERS *of gas turbines, expansion joints and aircraft engine, airframe and missile components.*

Reliance Boiler Safety Equipment is a profitable investment for your power plant

Don't overlook the relatively *small* equipment that keeps the *big* equipment running smoothly. Reliance Safety Devices are mainly applied to boiler water level supervision, but the well-being of your boilers affects other "big" equipment, as you know. So the selection of high grade accessories for the boilers is of major importance.

Water Columns and Gages are basic equipment you must add to your boiler when installed, or order with it from your boiler maker. Reliance offers you complete service in approved devices for water level supervision, including extra alarm devices that help insure attention of operators if a dangerous water level situation threatens. Reliance representatives in all major cities are ready to help you at any time.

The Reliance Gauge Column Company
5902 Carnegie Ave., Cleveland 3, Ohio



Water Columns for all pressures, with or without alarms.

Water Gage Valves

Gage (try) Cocks

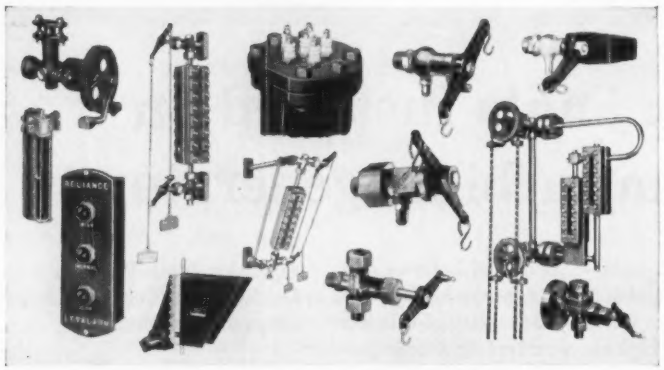
Gage Inserts

Direct-to-Drum Gage Assemblies

Water Gage Illuminators

EYE-HYE Remote Reading Water Level Indicator

Float-type and Electrode-type Liquid Level Alarm Devices



The name that introduced safety water columns....in 1884

Reliance®

BOILER SAFETY DEVICES

Marmaduke

Continued from page 146

"Our main engine was a 3200-hp triple-expansion job with a 70-in. diameter low-pressure cylinder. At midnight I had the first assistant and his boys lift the low-pressure cylinder cover. We jacked the l-p to the bottom end. I carried my remaining 19 cases below, took out the bottles and stacked them on the piston. They just squeezed in when we closed her up. The first assistant used the 40-in. intermediate cylinder. With her piston on the quarter, he only had room for two rows of bottles, so he hid the rest in the evaporator.

"When we tied up that morning, the custom inspectors came aboard. They headed for the engine room first thing. I had a reputation in Baltimore in those days, and the chief inspector greeted me with 'I don't know where you've got the stuff this time, Chief—but wherever it is, we'll find it.' 'Bilgewater,' I answered, 'and if you do, it'll be an accident, as usual.' He took his gang below and they started snooping around, looking in cofferdams, ventilators, lockers, the shaft-alley tunnel-well, and everywhere else.

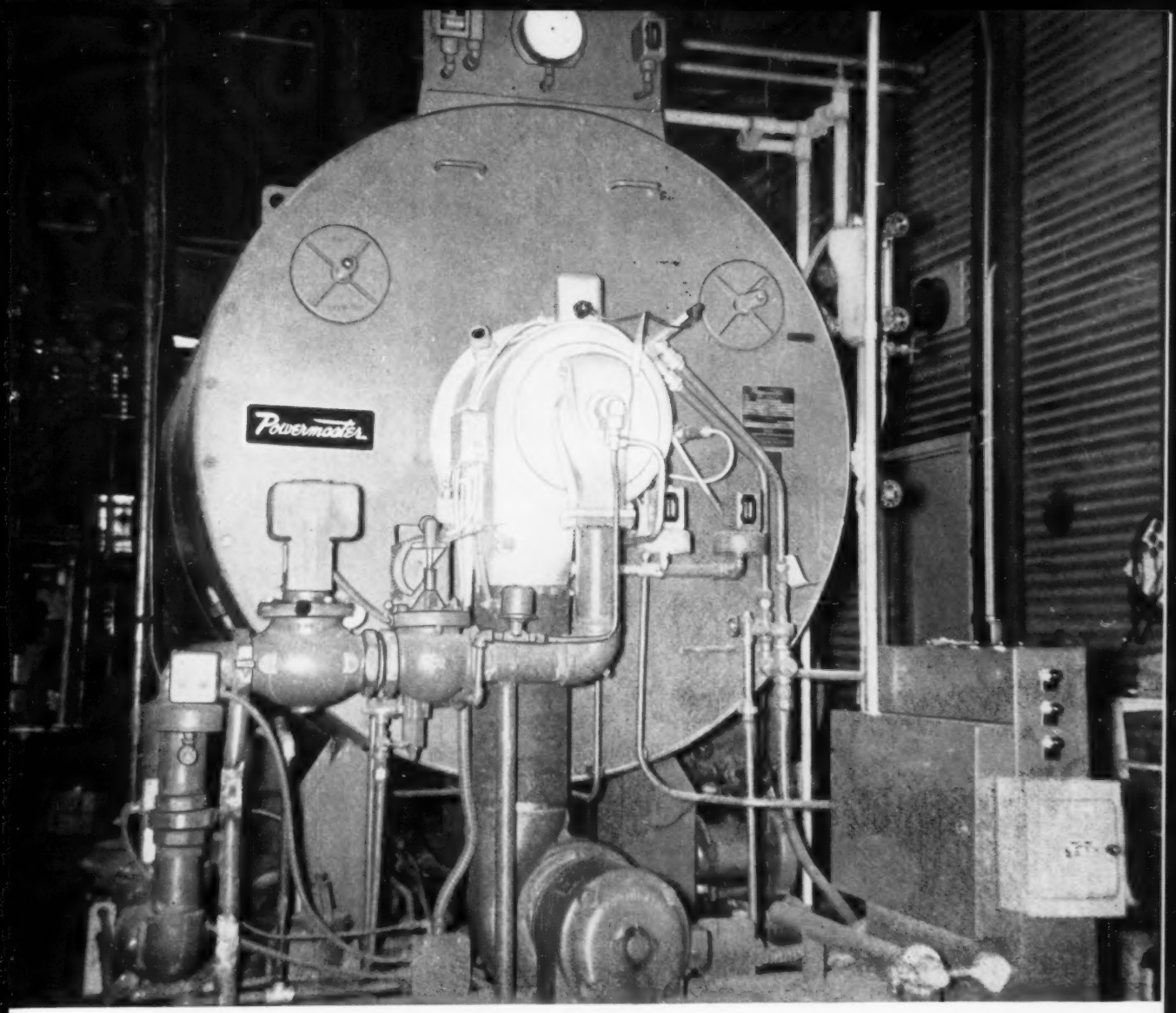
"Just then the captain told me he had word from the home office we were to have both annual and boiler inspection at 10 am. That was a fast one. Usually a full trip's warning is given, so the ship's officers can have everything ready. During these inspections, all machinery is examined inside and out, while shut down and while running. Then extra hawsers are put out and the ship makes a dock trial. The engine turns at about 40 rpm—if the dock can stand it.

"So there I was! The main engine full of Scotch worth $20 a bottle, the custom inspectors snooping around in the engine room, and the inspectors coming aboard at 10 am.

"Moving my bottles was out of the question. I couldn't tell the custom inspectors the Scotch was in the main engine, because they'd haul me in to say nothing of confiscating my Scotch. And I couldn't get out of turning the main engine over, because my license was at stake. Besides, if I didn't, someone else would.

"Of all the tough spots I've been in, that was the toughest."

"By 11 am the boilers were inspected and we had steam up to the



Powermaster® BURNS 56% LESS FUEL...SAVES OVER $3500 A YEAR FOR LAUNDRY & DRY CLEANER

This 125 hp, 125 psi, gas-fired *Powermaster* Packaged Automatic Boiler has been more than paying its own way in fuel savings since installation. How is it able to provide such outstanding performance? . . . Because *Powermaster* burner design gives infinitely variable combustion control that instantly responds to load changes. This provides high fuel economy and eliminates much maintenance due to incomplete combustion.

This unit is operating in an Omaha laundry and drying cleaning plant and has saved its owner on maintenance costs in addition to $3505.39 in cold, hard cash for 12 months' fuel.

How much do you think you could save with a *Powermaster?* Chances are that you'll save more than you expect. Most new *Powermaster* owners do. For some examples, write today for latest Bulletin.

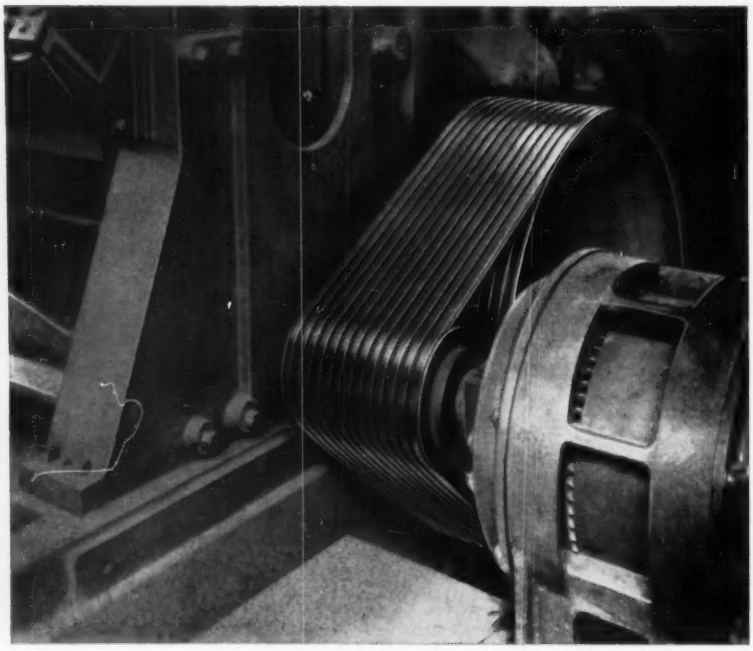
Powermaster®
PACKAGED AUTOMATIC BOILERS

Sizes to 500 hp; pressures to 250 psi

Builders of Dependable Boilers Since 1885

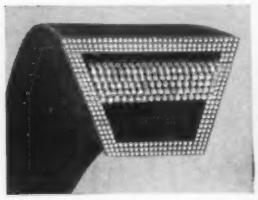
ORR & SEMBOWER, INC.

Morgantown Road, Reading, Pa.

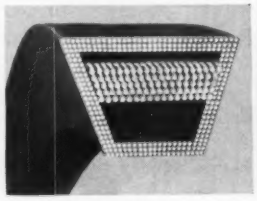


WHICH QUAKER V-BELT is right for your job?

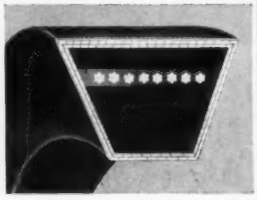
Quaker offers you a full line of tough, long-lasting V-Belts, each designed to do a specific job and give long, efficient service. For example . . .



For drives requiring additional horsepower, the Quaker Super V-Belt—40% stronger than standard—is available in a complete range of sizes, AP through EP cross-section.



For normal operating conditions without special speeds, loads, or center distances, the Multiple V-Belt, at reasonable cost, from 26" to 660" in all cross-sections from A to E.



The Quaker Fractional-Horsepower V-Belt gives quiet operation without vibration, stretch, or twisting. Ideal for light-duty applications. Available in lengths from 15" to 100".

HOW TO SELECT V-BELT DRIVES. Send for this free, illustrated, 72-page handbook packed with such facts as service factors, recommended cross-sections for various horsepowers and speeds, maintenance hints. Write to *Quaker Rubber Division, H. K. Porter Company, Inc., Philadelphia 24, Pa., or Pittsburg, California.*

H. K. PORTER COMPANY, INC.

QUAKER RUBBER DIVISION

Marmaduke

Continued from page 178

engine's throttle. The by-pass was cracked and the main circulator started. The bridge called down that they were ready for dock trials.

"The first assistant made himself scarce and left me in the engine room with all the big shots, and the chief customs inspector kept breathing down my back. That guy sure got my goat.

" 'OK, Chief,' said the port engineer, seeing that I was stalling, 'Let's get her turning. I got to catch a train at two.' This was it! They all stood near the throttle, so I had no choice. It was like asking a condemned man in the electric chair to throw the switch himself!

"Since I was paying for this party, I figured I might as well give them a show they'd remember. With the high-pressure piston on the quarter, she was just right to turn without rocking back and forth. I grabbed that throttle and yanked it open wide. DID SHE TURN? SHE SURE DID!

"There was the damndest crash ever heard on this side of Hell.

"But why go on?" Surfaceblow sighed. He stopped talking. We were on the edge of our stools. But for the first time in the many years we've known Marmaduke, his foghorn voice failed, and tears the size of seagull eggs streamed down his leathery cheeks.

Before the startled audience could say anything, he grabbed his half-filled bottle of Sandpaper Gin and drained it in one gulp. Finally, he squared his shoulders and navigated out the Bent Propeller Bar, mopping his face with a big red bandana.

It was then we realized that Marmaduke Surfaceblow had just told us the greatest single tragedy of his whole life.—STEVE ELONKA.

TRUER WORDS NEVER SPOKEN

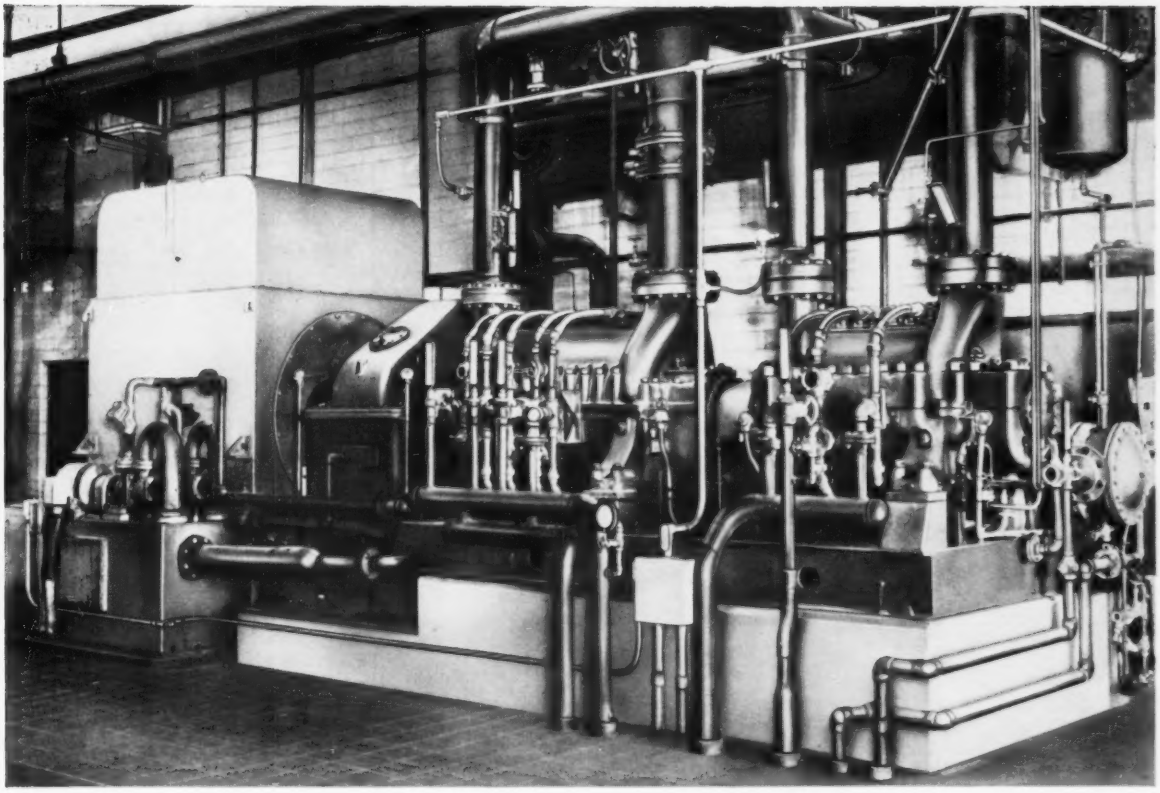
After years of working with coal passers, oilers, operators, consulting engineers, salesmen, college professors and administrators, I can appreciate Marmaduke. Fact is, I always get a chuckle from his stories because they're true to life. Enclosed is a check for his book.

A NAAB, *Indianapolis, Ind.*

READS MARMY'S BOOK

The Marmy book is super. I really enjoy the old boy's adventures.

GENE RICHNER, *Rochester, N. Y.*



Two Clark centrifugal compressors, an 8-stage No. 1 and a 10-stage No. 2, diaphragm cooled, with tandem drive at Public Service Electric and Gas Company's new Linden Generating Station.

Clark—first with Centrifugals for

SOOT BLOWING

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Double-wall cooled diaphragms provide the simplest, safest, and most effective way to cool a multi-stage centrifugal compressor. Clark diaphragm cooling permits a greater pressure rise in a single case, using less horsepower than uncooled designs. It also assures accurate temperature control.

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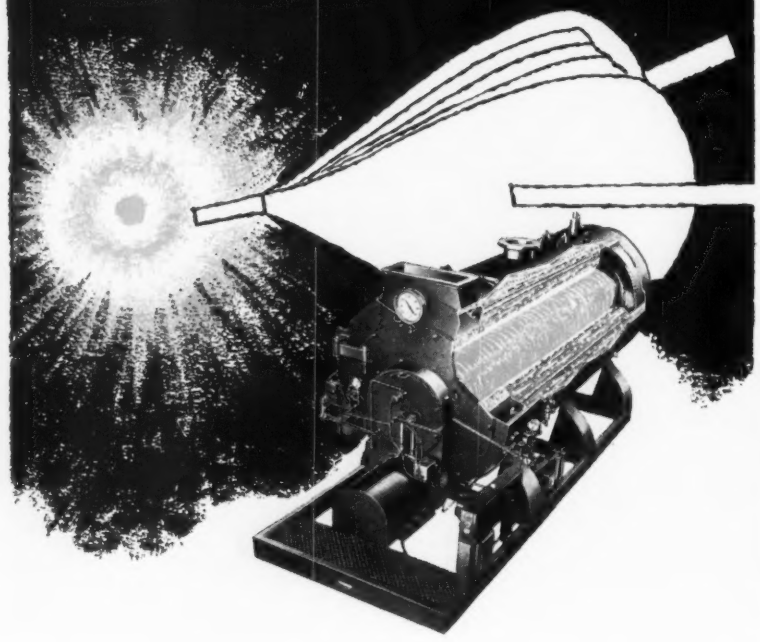

It takes air to promote combustion and when air enters the Cyclotherm combustion chamber at a tangent and with velocity up to 200 mph, really efficient combustion results. The air, assuming cyclonic shape and motion, combines with the fuel to form a flaming vortex spiraling the entire length of the firetube. This Cyclonic Combustion achieves 65% heat transfer efficiency in the firetube alone. An additional 15% is produced in the single pass of return tubes. Cyclotherm guarantees a minimum of 80% efficiency in only two passes.

Cyclotherm also includes an electronic control system for automatic operation. On models up to 60 hp burner automatically shuts off when steam demands are satisfied; resumes when steam is again needed. On larger models, precision modulation automatically regulates firing rate from 30% to 100% without loss of efficiency.

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Residual voltage

Continued from page 93

bus will not provide full protection for these motors with contactors. This is because contactors will normally drop out at voltages considerably above 25% and therefore interrupt the circuit to the bus. When a bus undervoltage relay set for 25% is used, it is a good practice to connect one or two of the largest motors to the bus through circuit breakers only so that the residual-voltage decay rate of these motors will control the time for bus transfer or reclosing of power. These motor breakers should also have time-delay undervoltage relays which will not trip them off the bus until after they would have time to normally "ride through" a short voltage failure.

(4) The final solution is perhaps the simplest and most inexpensive for the protection of 2300-volt and 4000-volt motors. That is to provide rectified dc power for the magnets of contactors in a special circuit to lower the drop-out voltage to below 40% and also to delay contact parting time for about one-third second. With this type of contactor magnet control, there is little additional cost in comparison to standard control. For a momentary system voltage dip as low as 40% the contactor will not drop out, and for a worse system voltage collapse but of less than one-third second duration, the contactor will also remain closed to protect and help the motor "ride through" the disturbance. If a voltage failure is of longer duration and the contactor opens, the residual voltage on the motor will be lower because of the delayed contact parting time, and so the decay time to 25% value will also be shorter. Thus, a motor with this type of contactor magnet control is less likely to be reconnected to the system under conditions where it would receive an excessive voltage as previously described. For the same reasons, it is also desirable to select 440-volt motor contactors with magnets having low drop-out voltage characteristics. And contactor maintenance such as keeping the air gaps clean, is important so that the drop-out voltage value will remain low.

Proper application and maintenance of motors is important but proper selection of motor control is also essential in order to attain re-

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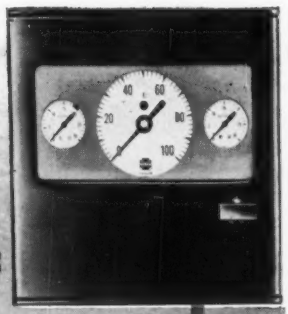

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Residual voltage

Continued from page 182

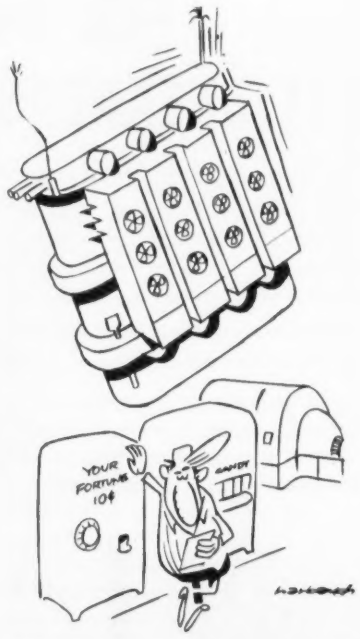
liable service under all conditions of operation on electrical power systems. When motor control is applied for automatic reclosing or when high-speed bus transfer is provided through automatic-transfer switches or tie circuit breakers, particular attention should be given to the protection of motors from possible damage or failure due to excessive reaccelerating currents caused by overvoltage.

References. (1) Backer, L E, P Barch, R A Huse and D W Taylor, *Transfer Tests on Station Auxiliary Busses*, AIEE Paper 55-92, published in *Transactions*, pp 1441-1449, Feb, 1956.

(2) Bellinger, T and S R Durand, *Operating Characteristics of High Capacity Air-Break Contactors on Industrial Power Systems*, AIEE Paper CP-266.

(3) Boice, C W, D Dalasta and S R Durand, *A Transient Stability and Voltage Study for a Modern Oil Refinery Distribution System*, AIEE Paper 56-767, published in *Transactions*, July 1957, pp 159-164.

(4) Moore, R C, "Residual Voltage in Induction Motors Influences Load Transfer Time," *Allis-Chalmers Electrical Review*, pp 28-31, Third Quarter, 1955.



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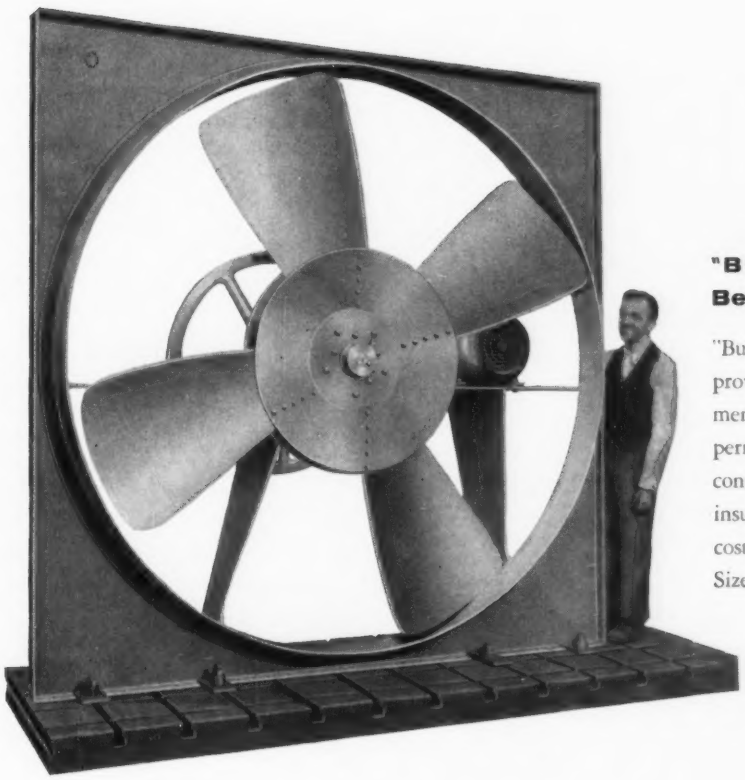

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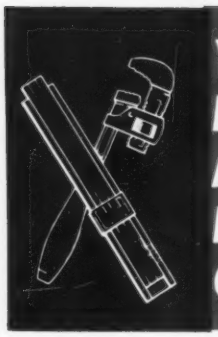

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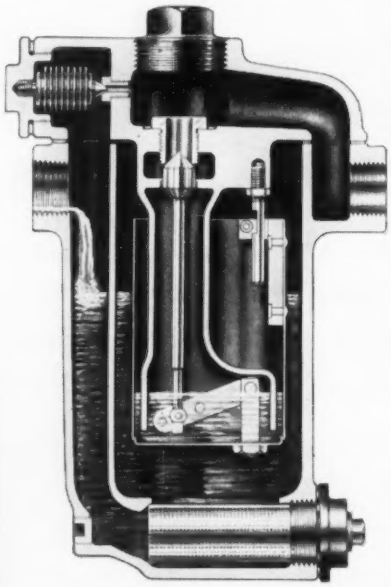

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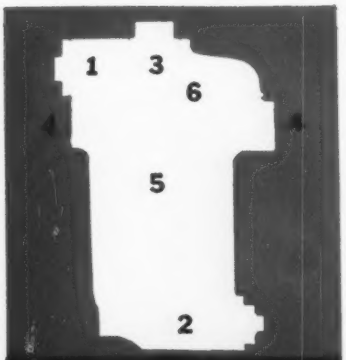

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Technical briefs

Begins on page 152

automobile exhaust have been directed toward elimination of unburned fuel (hydrocarbons) and nitric oxide. The attack on the hydrocarbons has been of a dual nature —improvement of combustion in the engine and burning excess fuel in the exhaust system. The status of these developments is described.

Less work has been done on nitric-oxide elimination, but two approaches to the problem are mentioned. Author concludes that exhaust-gas afterburners and nitric-oxide eliminators offer the most promise for control of motor-vehicle exhaust gas. *ASME paper, No. 57-A-245*

Atomic power

Vallecitos developmental boiling water reactor. *By S Untemeyer II, General Electric Co*

The Vallecitos Atomic Power Plant at Pleasanton, Calif., went to full authorized power, 20,000-kw thermal and 5000-kw electrical, in October. The GE developmental boiling water reactor is connected to a 5000-kw steam turbine-generator owned and operated by Pacific Gas and Electric Co. Construction management for the project was performed by the Bechtel Corp, who acted as architect-engineer.

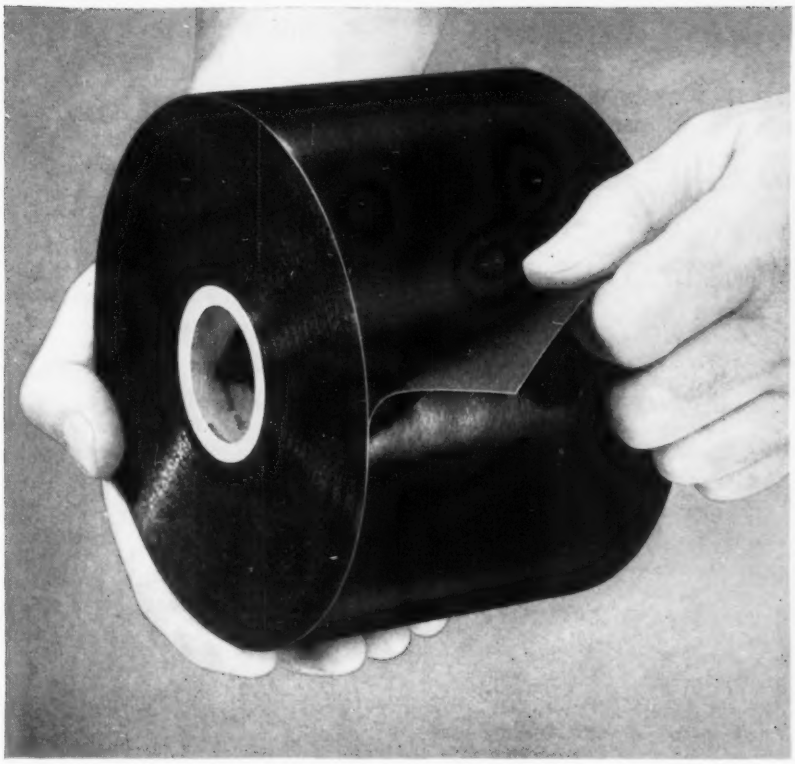
Start-up and subsequent operations of the power plant indicate that it's a complete success. The owners believe it's capable of producing substantially more than the 20,000-kw thermal presently authorized.

Cost of the project was about $2,500,000 for GE, about $500,000 for Pacific Gas and Electric Co. These costs are essentially bare costs and are not indicative of the cost of similar facilities constructed for a utility customer. Substantial additional expenses would be required for land, supporting facilities, commercial and administrative expenses, etc. *AIF paper, No. 57-AIF-111*

Yankee Atomic Electric Co Project. *By A E Voysey, Westinghouse Electric Corp and R J Coe, Yankee Atomic Electric Co*

Since the contract between AEC

Directions for ordering papers on page 188



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. . . for measuring direct current at voltages up to 100 kv when applied to the insulation of generators, transformers, bushings, cable, etc.

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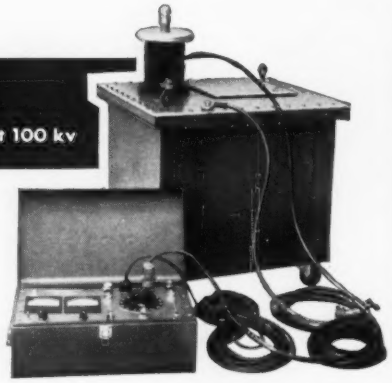
current output 6 ma continuous at 100 kv



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Technical briefs

Begins on page 152

and Yankee was signed in June 1956, Yankee has been progressing on several fronts. The research and development program is well underway through a subcontract with Westinghouse; Westinghouse and Stone & Webster Engineering Corp are proceeding as joint contractors with the engineering design. A license application has been filed with AEC including the required *Preliminary Hazards Summary Report.* Rough grading and work on access roads and railroads will start shortly and major construction will begin in the spring. Plant completion is scheduled for 1960.

Conceptual design has been completed and many major equipment items, including the reactor vessel, steam generators, primary coolant pumps, turbine-generator and condenser, have been ordered.

On a base-load schedule of 7000 equivalent full-power hours output per year, it is hoped that Yankee can achieve a cost per kwhr of 14 to 16 mills, compared with 9 to 10 mills for a conventional plant. It doesn't seem unreasonable to hope that such a discrepancy can be reduced and even eliminated as more of the problems of this type of reactor are defined, investigated and solved. *AIF paper, No. 57-AIF-55*

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American Society of Mechanical Engineers. Identified by initials ASME and obtainable from ASME, 29 W 39th St, New York 18, New York.

Atomic Industrial Forum, Conference on Management, Economics, and Technology for the Atomic Industry. Identified by initials AIF, and obtainable by purchase from AIF, 3 E 54th St, New York 22, N. Y.

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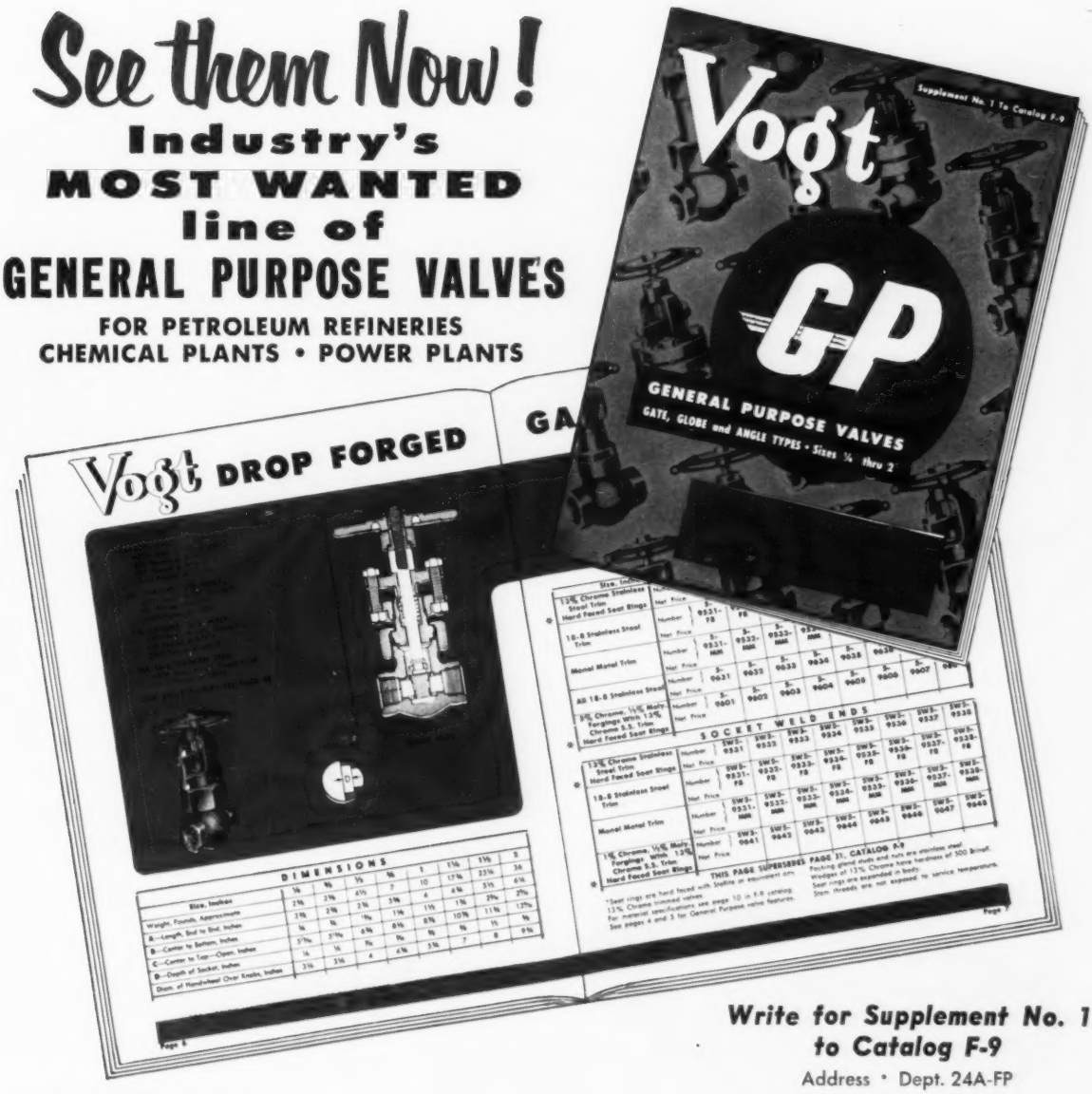

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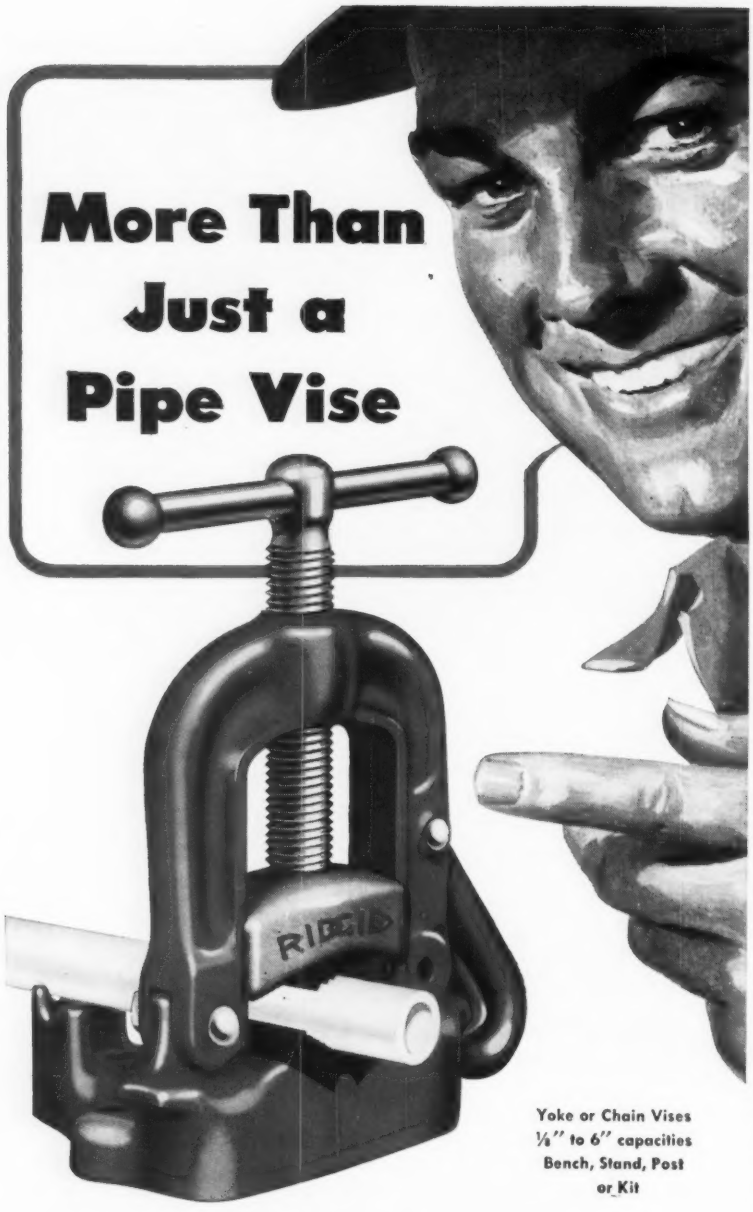

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My biggest boner

Many years ago I was the transformer repair man for a hydroelectric company. Transformers in one station were all of the shell type, with very low impedance. Nearly every lightning storm took its toll.

Shell-type transformers have one half of the coils wound clockwise and the other half counterclockwise. Idea is to bring top ends of two outside coils of stack so leads going to bushings will be on outside or top of coils. This is important on high-voltage windings or high-voltage lead would be down at bottom and close to the iron. Also, the last ten or twelve turns of the two high-voltage coils had additional insulation as protection against surges.

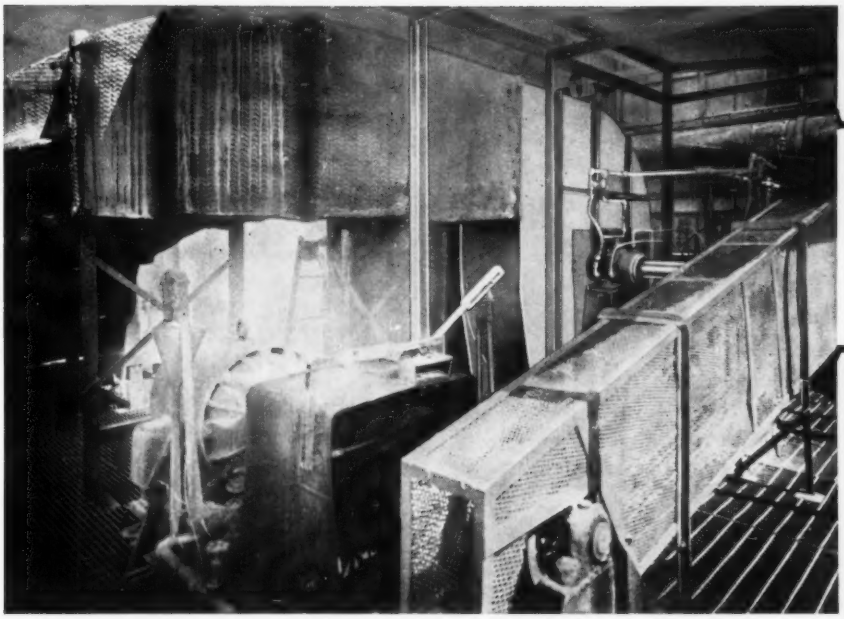
Upon rebuilding a 2000-kva transformer and stacking the iron, I made the usual ratio check. Something was wrong. I checked the voltage across each h-v coil. All were OK. I made a progressive check across the h-v winding from coil to coil. Voltage added up as it should until I hit the last outside h-v coil. But I had a bucking coil.

I was pretty green and plenty worried. It took me some time to dope out what was wrong, but I finally realized I'd pulled a boner—I had neglected to thoroughly check the groups of clockwise and counterclockwise coils. My last outside h-v coil was reversed.

I knew that by reversing the connections on this coil it would correct matters as far as the ratio was concerned—but by so doing I would have the high-voltage lead going to the bushing down at the bottom and close to the iron.

I decided to go to the super, a rather severe old fellow, and tell him I'd pulled a boner. To correct the transformer properly it would be necessary to take off all the iron, undo the core and reverse my "reversed" coil. I expected to get fired. The super bawled me out about not being careful when checking coils, but since the transformer was needed badly, he decided to take a chance as she was. On leaving he said, "Mac, don't do it again." I didn't.

L McWilliams, *Shawinigan, Que.*



One of several Clarage Type XL Fans used in this application. Fan equipped with stainless steel wheel and V-belt driven from a hydraulic coupling.

Clarage Fans have what it takes

for this tough exhaust assignment in the production of titanium dioxide

Exhausting 800° F gases from rotary calciners through scrubber units and electrical precipitators to the atmosphere.

That's the demanding task this large chemical manufacturer gave Clarage Type XL Fans.

What kind of a job evaluation does Clarage receive? Several repeat orders furnish the answer. In fact, three additional Clarage Fans will soon be installed in a major expansion at this plant.

You, too, will find it pays dividends to choose the fan name of quality — Clarage. Call us in for capable assistance on your next requirements in the air handling and conditioning field. It's characteristic of Clarage equipment to prove out successfully no matter how exacting the application. CLARAGE FAN COMPANY, Kalamazoo, Michigan.

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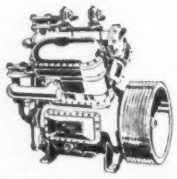
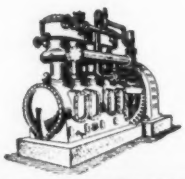
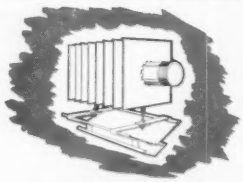


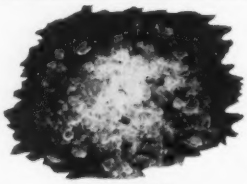
ECLIPSE COMPRESSORS



HEAVY-DUTY COMPRESSORS



PREST FIN PIPE COILS



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DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA., U. S. A.

Compressed air

Continued from page 97

the discharge stroke. The moving piston also imparts energy to the discharging gas molecules, which raises their pressure, see Part 14, December 1957, pp 114-115. By the time the piston comes to a stop at the end of the discharge stroke the air pressure does drop to discharge-line pressure, at state *3*.

In expanding the clearance air, the actual process again lies between constant-T and constant-S so the clearance air reaches atmospheric pressure sooner than the ideal constant-T. Pressure, however, surges below atmospheric to open the admission valve and allow free air to enter the cylinder. Again we have pressure waves set up in the entering air because of varying piston speed during the stroke, but pressure level stays below atmospheric during admission stroke, and almost reaches it at the end, state *1*.

Net enclosed area of the actual compressor graph or card is larger than the ideal, shaded area. This means that an actual compressor needs more work input than an ideal compressor working between the same pressure limits. The irreversible processes we described contribute to the relative inefficiency of an actual compressor.

Fig. 3*b* compares the ideal and actual cards for an air engine. Here the irreversible effects make the net area of the actual engine less than the ideal constant-S engine. This means an actual engine produces less work than the ideal. Principal adverse effects are the lower admission pressure and higher exhaust pressure.

Performance factors. In Part 14, December 1957, we discussed the effect of clearance volume in a general way. To handle the maximum mass of air in a given compressor cylinder we obviously want to make the clearance volume as small as possible. Let's find out what factors affect the amount of air handled by a cylinder.

Conventional volumetric efficiency, e_v, of a compressor (ideal) is defined as the ratio of compressor capacity to piston displacement. In Fig. 4*a* compressor capacity is $V' = V_1 - V_4$ and piston displacement is $V_D = V_1 - V_3$.

(*Continued on page* 194)

Always Stronger Than They Need Be!

MIDWEST

WELDING FITTINGS

Below are photographs of two of the many tests that have been made of Midwest Welding Fittings. The results are *always* the same . . . the seamless pipe to which the fittings are welded invariably bursts. There is *never* any sign of fitting failure or weakness.

There's good reason for this. We make elbows and tees of inherently stronger metal . . . the Midwest exclusive method of manufacture enables us to maintain greater minimum wall thickness, and to reinforce the fittings at points of greatest stress. For the many other advantages of Midwest Fittings, ask your Midwest distributor or write us for Catalog 54.

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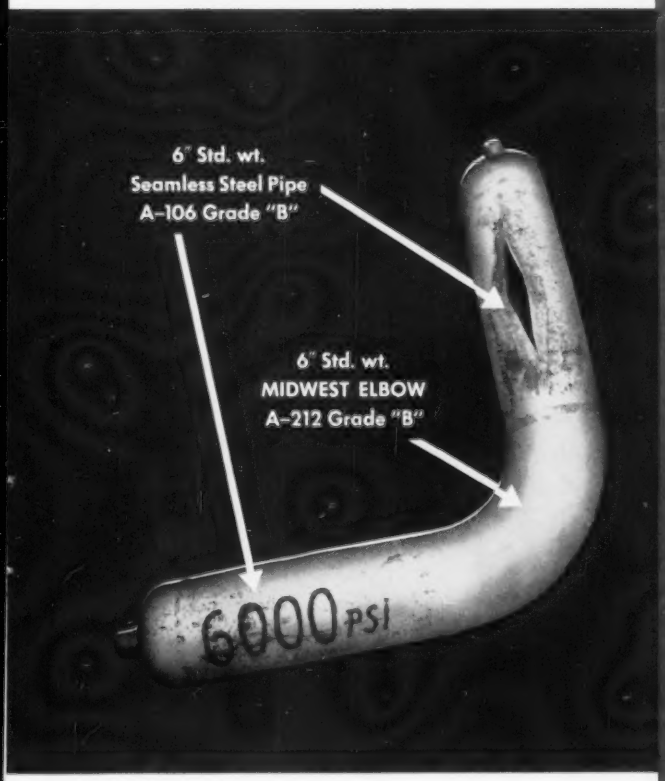

Typical bursting test of stock Midwest Welding Elbow. As is always the case, failure occurred in the seamless pipe while the elbow was undamaged. Bursting pressure was 6000 psi . . . considerably above the required code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

Bursting test of Midwest Welding Tee taken at random from stock. As always, the failure occurred in the seamless pipe and not in the fitting. The non-shock internal bursting pressure of 6200 psi is well above the code minimum for seamless pipe. (Minimum allowable bursting pressure for 6" standard weight A-106 Grade B seamless steel pipe is 4438 psi.)

7761

MIDWEST **WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS**

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Five factors influence the choice of a dust collection system: dust characteristics, gas characteristics, efficiency required, installation and operation costs, and limitations of space or draft loss. In every installation, exclusive Buell features provide *extra efficiency*. A booklet, "The Collection and Recovery of Industrial Dusts", provides valuable, specific details. Just write Dept. 50-B, Buell Enginering Company, Inc. 123 William St., N. Y. 38, N. Y.

A **Buell Cyclones** offer exclusive Shave-off which harnesses double-eddy currents and puts them to work, large diameter design which eliminates bridging and clogging.

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buell®

Experts at delivering Extra Efficiency in

DUST COLLECTION SYSTEMS

Compressed air

Continued from page 192

Percent clearance for a compressor is defined as $c = V_c/V_D$. Then:

$$e_v = V'/V_D = (V_1 - V_4)/V_D$$

But:

$$V_1 = V_D + V_c = V_D + cV_D$$
$$V_4 = V_3 (P_3/P_4)^{1/n}$$
$$= cV_D (P_2/P_1)^{1/n}$$

Substituting:

$$e_v = \frac{V_D + cV_D - cV_D (P_2/P_1)^{1/n}}{V_D}$$

$$e_v = 1 + c - c \left(\frac{P_2}{P_1}\right)^{1/n}$$

This means the conventional volumetric efficiency depends on the percent clearance and the pressure ratio, as well as the polytropic coefficient n. Fig. 5 shows how these factors are related.

Power Test Code 9-1954 *Displacement compressors, vacuum pumps and blowers* published by the American Society of Mechanical Engineers covers the method of defining and testing the performance of actual compressors.

Next part starts internal-combustion engine cycles—in a forthcoming issue.

Condensate handling

Continued from page 99

before the condensate passes through any heaters so heat is not wasted unnecessarily. Take-off point should also be before the hotwell-level control valve so full pump pressure is available to recirculate a maximum of water back to the condenser. If take-off is after the control valve, the only head available is that necessary to force the condensate up to the deaerator, and at low loads that may be only a few pounds.

Trouble shooting. To prevent air from entering the condenser, turn on steam to the air jet before opening the jet suction valve, and do not shut it off until the suction valve is closed when taking a jet out of service. Low vacuum has often tripped turbines off the line because this precaution was not observed. This is particularly likely to happen when using the hogging jet.

With two jets in parallel on a stage and one of them shut down but with

Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

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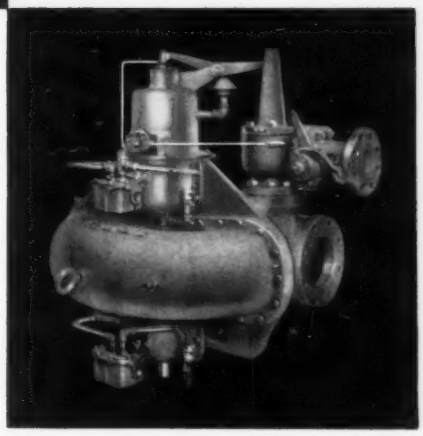

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Ideal for Hospitals, Hotels, Apartments, and Industries where noise is objectionable.

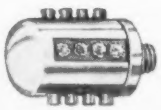
Rotojet Electric Tube Cleaner thoroughly cleans straight tubes from 25/32" to 4" I.D. in boilers, condensers, evaporators, and heat exchangers so quietly that it can be operated without disturbing anyone.

This self-contained unit comprises a powerful motor, rotatably mounted on a stand, a required length of heavy duty flexible shaft, a 20 ft. cable, and a selection of heads, brushes, drills, and scrapers to meet any cleaning need. The motor swivels and rotates so that tubes on top, bottom, and sides can be cleaned without moving the unit. A few of the many types of heads available are shown below.

Bulletin 107 gives full details of this quiet, efficient, convenient tube cleaner. Send for it now.

Rotojet Electric Tube Cleaner with swing-frame head.

4-way drill and universal coupling.



Expanding wire brush.

ELLIOTT COMPANY – ROTO PLANT
DIVISION OF CARRIER CORPORATION
Tube Cleaner Specialists Since 1910
153 Sussex Avenue, Newark, N. J.

Condensate handling

Continued from page 194

suction and discharge valves left open, air can recirculate between the active and the inactive jet. This reduces air-handling capacity.

Steam-jet nozzles are usually made of erosion-resistant material so wear is not a problem. But carryover in the steam may cause deposits that restrict or alter steam flow and prevent effective air entrainment. Occasional inspection and cleaning insure against this trouble. Take care to assemble the nozzle parts exactly as they came out; their position in the nozzle case may be quite critical.

As mentioned above, loss of seal in the intercondenser drain loop causes loss of capacity. If the seal becomes plugged or if the condensing surface floods because traps on the aftercondenser are not working or a tube is leaking, the effective condensing surface is reduced and secondary jets are overloaded. A badly flooded steam-jet air pump ejects warm, moist vapor approaching steam conditions from the air-outlet pipe.

Occasionally, you may get air recirculation because of a poor joint between tube sheets and the ends of the baffle that separates primary and secondary condensing portions of steam-jet air pump. Tube sheets are usually bolted up against the baffle and outer casing; an asbestos gasket seals the joint. Condenser tubes are then rolled into place. They hold well enough so it is difficult if not impossible to later pull the heads up against the baffle ends to tighten gasket joint. Leakage shows up as a lack of air-handling capacity.

With the unit out of service, you can make a positive check for poor joints by filling the intercondenser space with water under a light pressure, say not over 10 psig, and then checking the aftercondenser drain for signs of leakage. If water appears, it indicates leakage at the baffle joint or through the baffle itself. Repairing such leakage is difficult as the tubes have to be cut or driven out of the tube sheets and then replaced or rerolled again after the gasket joint is made up.

Water-operated jets may be used instead of steam to handle noncondensable gases from a condenser. A group of nozzles using high-pressure water is arranged so gas particles are

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structural details?

. . . many things.

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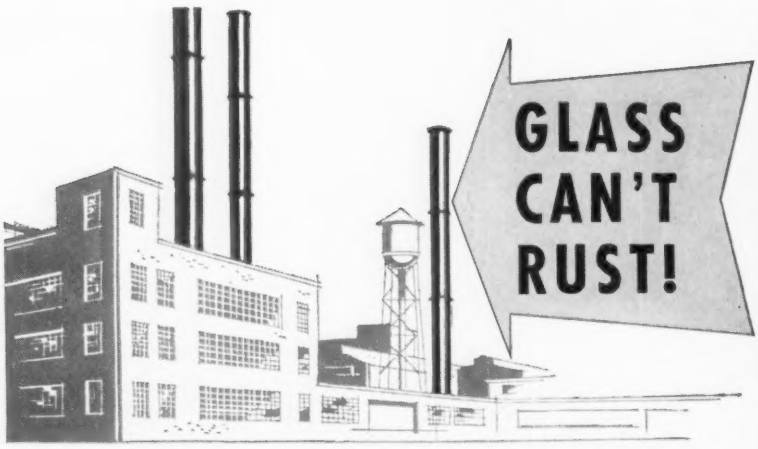
- A mass flow soot blower is installed as original equipment at the cold end where deposits are most apt to accumulate.
- The hot end heating surface is made from open hearth steel sheet and the cold end from heavier gauge, low-alloy corrosion-resisting material because corrosion is normally confined to the cold end.

The Air Preheater Corp. is constantly working to improve Ljungstrom heating surfaces, seals, bearings, and other structural details. And, in general, these improvements can be applied to existing units with only minor changes and at nominal cost. Another reason why seven out of ten air preheating installations are Ljungstrom. For the full story on how the Ljungstrom design and construction can cut your fuel costs, increase plant efficiency, write for our 38-page manual.

The Air Preheater Corporation, 60 EAST 42ND STREET, NEW YORK 17, N. Y.



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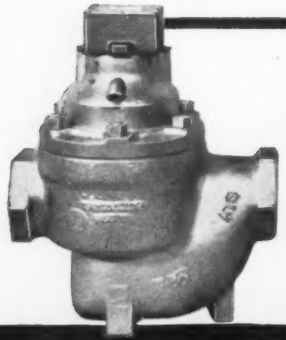

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A rugged, heavy duty meter adaptable for many liquids. Measures with extreme accuracy regardless of the liquid's temperature or gravity.

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Condensate handling

Continued from page 196

entrained between the water droplets and carried out a nozzle throat into a separating tank. Several nozzle groups may be used. Cool water in direct contact with the gas immediately condenses the condensables. Water and noncondensables discharge into the closed tank that serves as supply pump's suction reservoir. Air and other gas is vented to atmosphere through an air-leakage meter.

Water-operated vacuum pumps require about the same precautions as hogging jets, where a single stage and no condensing surface is used. Plugging, erosion or deposits may affect nozzle efficiency enough to impair air-handling capacity. When cutting units into service, turn on water before opening suction valve; when shutting off, close suction valve before turning off water.

Condensate pumps are sometimes combined with air removal by using the condensate to entrain the noncondensable gas before water discharges from the pump. This type of unit has been largely supplanted by the steam jet.

Condensate pumps must be of a special type having a low suction-head requirement since they handle a liquid that is very close to flashing temperature. Ordinarily, they cannot have much suction head because this would require raising the condenser or lowering the pump. Either expedient would cost a considerable amount of money. Therefore, these pumps have large impeller eyes for the first stage to minimize flashing and cavitation. They need a large vent line back to the condenser to permit priming. Shaft packing glands are almost always water-sealed to minimize air leakage. Condensate taken from the header should be used for this service, rather than condensate taken from the individual pump. Thus pump is sealed when standing idle but held in readiness for immediate service.

Like circulating-water pumps, condensate pumps may be either horizontal or vertical. Vertical pumps are gaining in recent installations. The horizontal type often has a double-suction impeller for the first stage so a lower suction head is required. Vertical type is usually set in a pit or recess in the basement floor; thus it

install heavy duty

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Here's a heavy duty packing ring, with nearly square cross section—*yet it's sensitive to the pressure of a finger-tight gland!* Inconceivable? Not when these unique design features are known:

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*Specifically designed for deep stuffing boxes.

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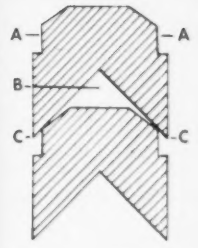
LONGER LIFE



A Recessed wall reduces contact area and friction.

B Reservoir for liquid being packed against.

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Condensate handling

Continued from page 198

has a few feet more of effective suction head. It, too, may use a double-suction first-stage impeller.

Most condensate pumps operate against a relatively low head, consisting of (1) condenser suction or vacuum (2) friction and static head of piping and heaters up to the deaerating heater (3) pressure in deaerating heater itself. The pumps are, therefore, of limited head, and usually have two or three stages.

Where condenser deaeration is used and water is pumped directly to the boiler-feed-pump suction, higher discharge head can be used. This may require a condensate pump with more stages or operating at a higher speed.

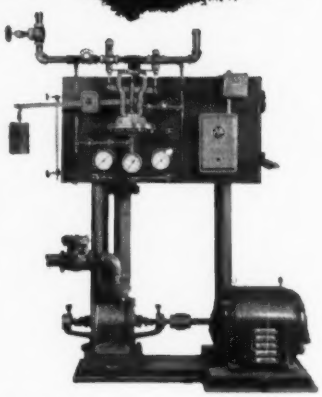
A screen placed in the hotwell at condensate-pump suction line opening or in line itself guards against possible pump damage from foreign material left in the condenser. Inspect screen periodically to see that it is clean and intact. During initial start-up, after overhaul and at other times when work is going on in the exhaust hood and condenser, be especially sure that all debris is removed from condenser tubes and hotwell. For initial start-up it is a good precaution to flush some water from the hotwell through pump suction line if this is convenient. Pumps may be run in at low load before the plant is started by recirculating water back to the condenser.

Pump suction is usually set well below normal hotwell level to assure a good water flow to pump impeller. If two or more condensate pumps serve one condenser, the idle one is usually kept ready for immediate standby service with suction and vent-line valves open, and possibly with discharge valve open also. Discharge line usually has a check valve, located near pump. If possible, this valve should be located below hotwell water-level. If it is not, the vacuum in the pump plus static head up to the check valve, may cause the water to "flash," creating a vapor pocket in front of the valve. Then when pump starts, you may get heavy water hammer as the vapor pocket collapses.

Condensate pumps are relatively simple to operate and maintain as they are low-head, low-speed units and operate with cool water. The

Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
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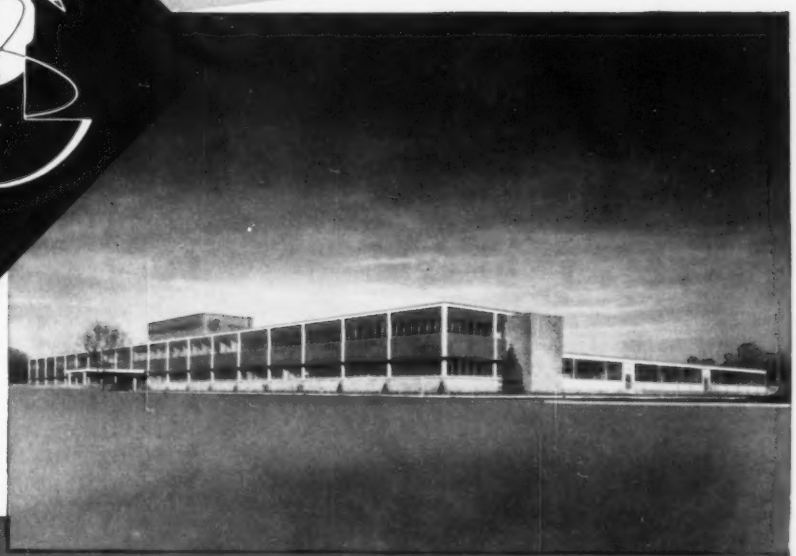

Photograph courtesy of Remington Rand Univac

Remington Rand Univac, Division of Sperry Rand Corporation, recently completed the above pictured multi-million dollar plant at Univac Park, St. Paul, Minnesota. To help protect this major investment, MOGUL water treatment products were selected.

Remington Rand has joined the growing list of many of the world's largest corporations that have MOGUL-IZED with Mogul Quality Products and Mogul Service.

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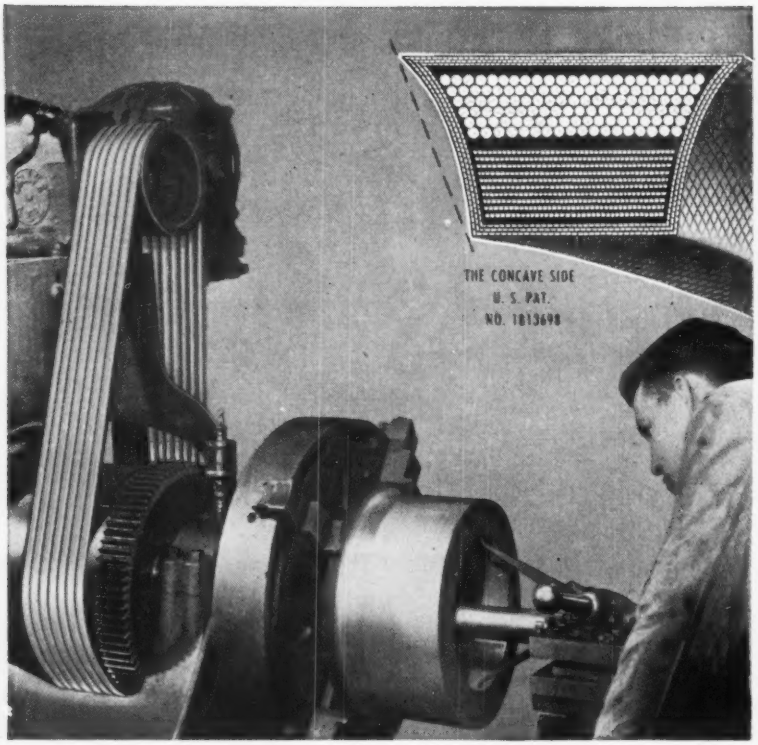

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Condensate handling

Continued from page 200

usual precautions regarding drive and pump alignment, bearing cleanliness, lubrication and venting apply. Until the pump is running, venting must be carried back to the condenser. Pump is under vacuum until that time and air would be pulled into the pump rather than vented from it if venting were to atmosphere.

Next article in this series will consider condenser testing and operation.

Valve standard

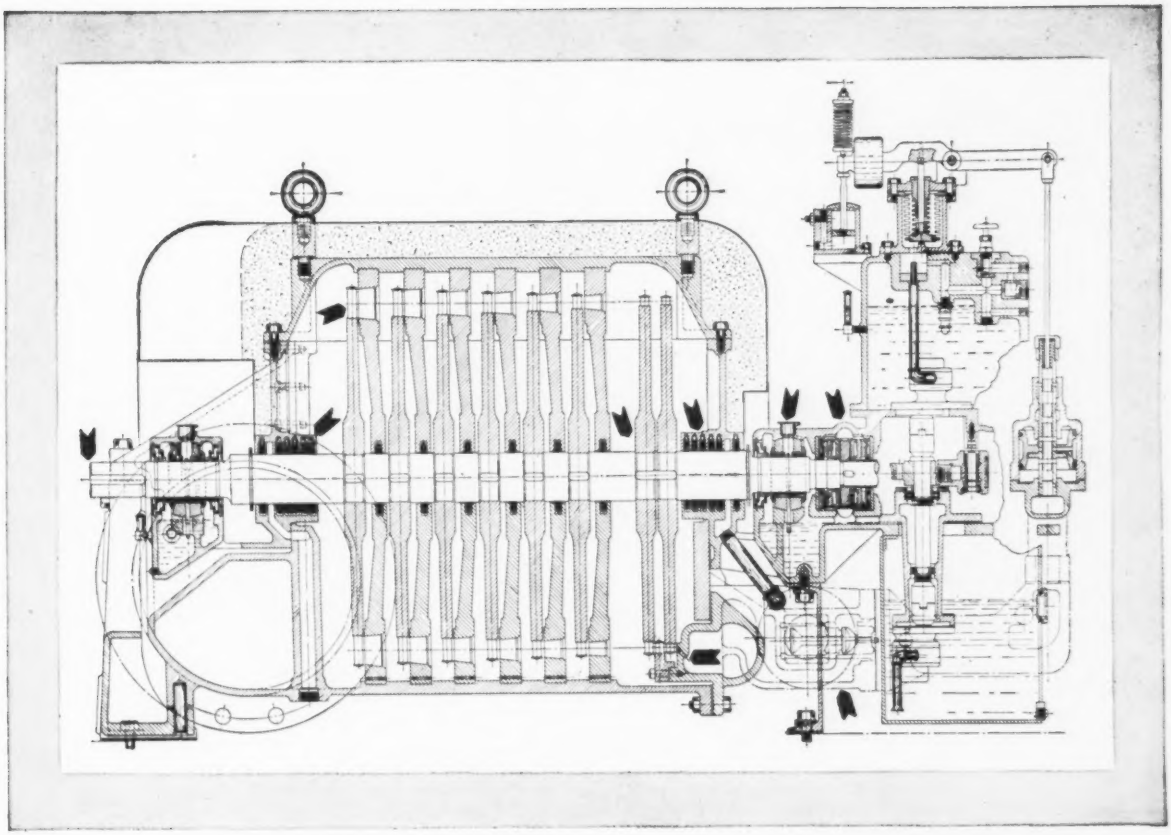
Continued from page 88

valve manufacturers will be saved considerable design calculations and submission of data to state *Codes* for approval if the 4500-psi series is established. We hope this article and discussion will stimulate enough interest to establish the 4500-psi series. The power industry can use it now.

NEWTON C EWALT, Chief Engineer, Walworth Co: I am taking the liberty of replying as chairman of task force appointed by the then chairman of ASA B16 Subcommittee 3, Mr F S G Williams, whom I succeeded. Based on considerable study . . . the task force recommended that a 4500 pressure class be established. This was submitted to letter ballot of the membership of ASA B16 Subcommittee 3, and . . . was overwhelmingly approved.

All valve design must start from a basic inside diameter of the port. . . . There is no standard for pipe bores having thicknesses greater than Schedule 160. And tubing for pressure-temperature ratings above a primary service rating of 2500 will have thicknesses greater than those of Schedule 160 pipe. So it appears that before any further progress can be made the tubing manufacturers and users should establish standards for tubing bores for these higher pressures. We do not feel that any one particular manufacturer should arbitrarily establish primary service pressure ratings. Subcommittee 4 of ASA B16 is charged with such duties. . . . Mr Crawford's article will help to stimulate serious thinking on this very important subject.

W C WOODMAN, Stone & Webster Engineering Corp: I agree that it is



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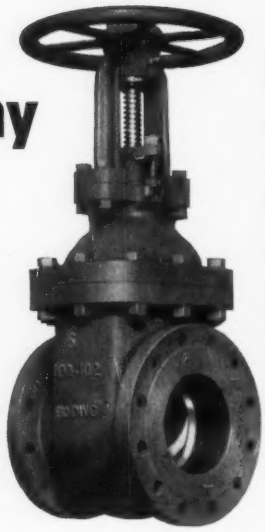

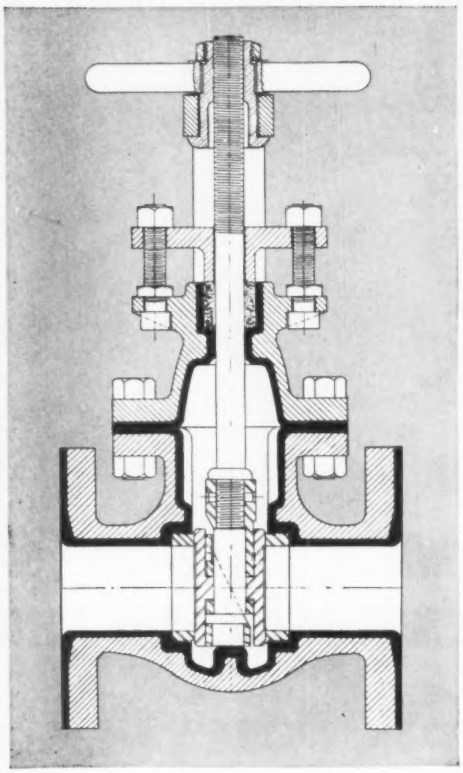

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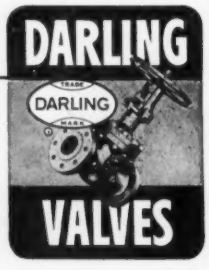


Valve standard

Continued from page 202

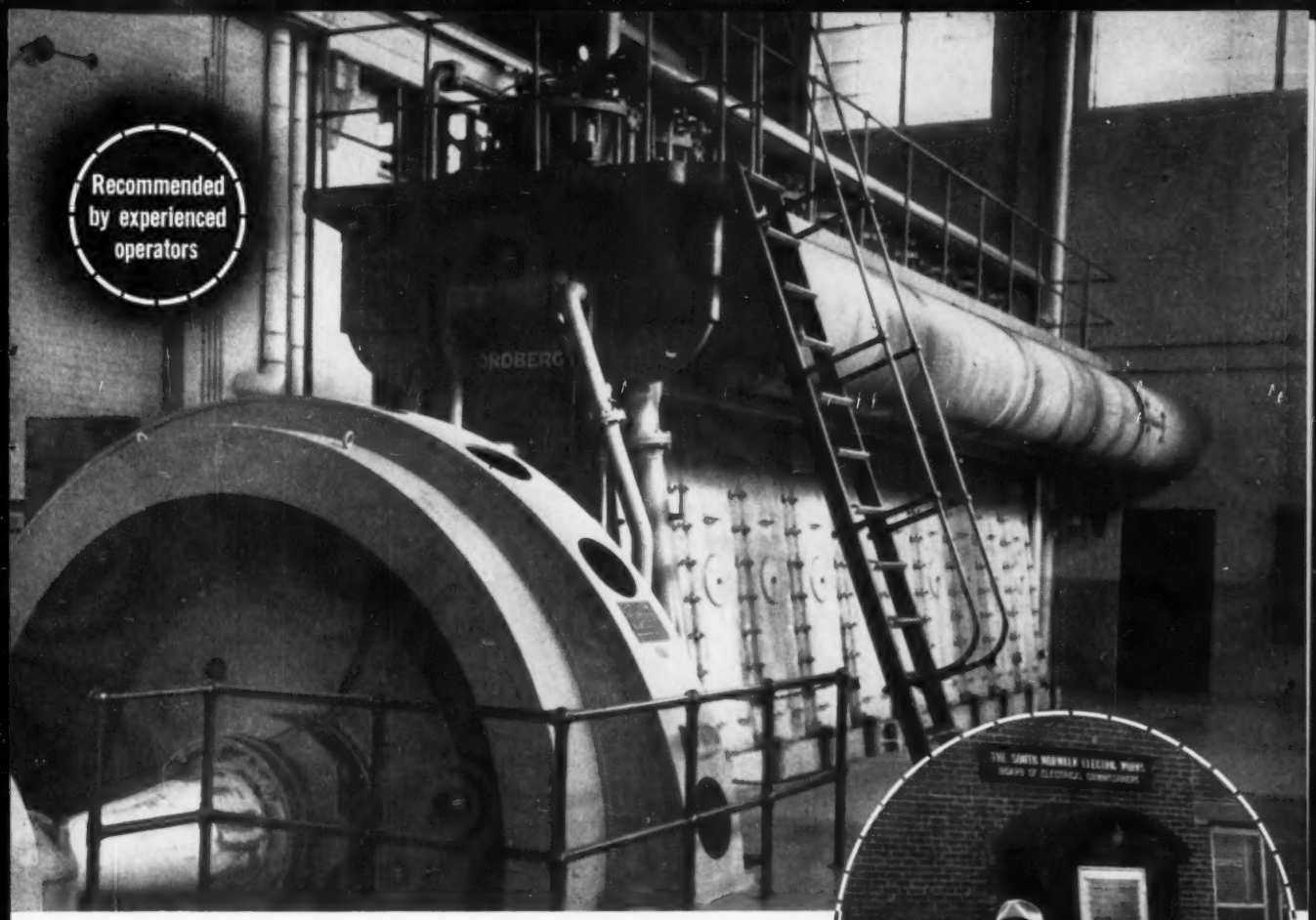
desirable to consider a new pressure standard for valves beyond the present 2500-psi classification, and that 4500 psi is a logical choice. . . . The ideas expressed about desirability of valve port areas matching the internal diameter of the thick-walled pipe required for 4500 psi are sound and do require some readjustment in our thinking as to the size of available port areas in valves.

A KOLFLAT, Sargent & Lundy: The commercial adoption of the proposed 4500-psi standard will, to some extent, depend on the price differential established by the manufacturer between 2500-psi and 4500-psi standards. Too wide a price differential may lead to an attempt to "beef up" the lower standard instead of adopting the higher standard. . . .

The author's reason for selecting 4500 psi seems quite logical. . . . For some time there will not be very many valves in this class and therefore it will be practical to establish a new standard at a considerably higher range than the present 2500 psi. The selection of different materials for various temperature conditions gives a wider pressure range to the standard than is implied in the rating itself. . . . Adoption of the new standard will offer considerable economies in manufacturing and design. . . . Detailed dimensioning is a subject for further discussion by standardization committees.

J H HARLOW, Chief Mechanical Engineer, Philadelphia Electric Co: It will be useful to have such a standard to which valves can be ordered in connection with the design of supercritical-pressure boiler plants. On the surface it appears reasonable to use stress values and coefficients as suggested in the *Boiler and pressure vessel code.* This is a design matter which I do not feel qualified to discuss. I feel it should be left to those who are skilled in valve design. Whether or not the pressure and temperature ratings as proposed by Mr Crawford are proper is a matter for ASA Committee B16.5 to determine.

R A HANDSCHUMACHER, Manager of Engineering, Yarnall-Waring Co: Choosing the new standard of 4500



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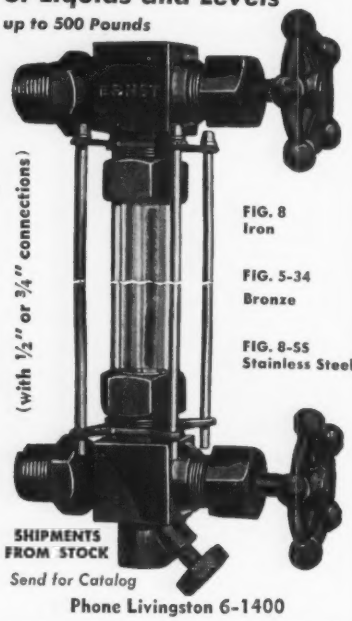

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FIG. 8 Iron

FIG. 5-34 Bronze

FIG. 8-SS Stainless Steel

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Valve standard

Continued from page 204

psi as the solution to the problem of high-pressure requirements over 2500 psi has been covered most effectively. It has been the natural preference of engineers in this field. Mr Crawford's approach to the design and pressure-temperature ratings is most interesting. We agree that the starting point in the design centers in the bore of the pipe to be used at the rated pressure. To date, an ASA *Standard* has not been developed for the schedule of pipe required for operation in the 4500-psi pressure range. We know, however, that the ASA B36 Committee is aware of this problem and we expect that they will meet this challenge.

It is most important to have a uniform method of establishing the pressure-temperature ratings of the 4500-psi valve, using different materials, compatible with the existing (lower pressure) ratings or with revisions of the existing ratings.

A F HARTUNG, Burns & McDonnell Engineering Co: Up to now in our own work we have not had an opportunity to require any valves with a rating higher than 2500 psi, but certainly a higher standard of valves will be required in the future. It is highly desirable to establish such a standard prior to the time that a large number of such valves is ordered. Mr Crawford's proposal to adopt a 4500-psi standard seems logical.

A B DONKERSLEY, Chief Engineer, Industrial Piping Division, Grinnell Co: There is no question about the need for an ASA valve standard above 2500 psi. A 4500-psi valve standard should have wide acceptance in the power industry. . . . Offhand, it appears that there will be possible economies to the purchaser in having a 4500-psi ASA valve standard, even though actual design conditions might be satisfied by a special design with rating above 2500 psi and less than 4500 psi.

T Y MULLEN, Chief Mechanical Engineer—Power, Burns and Roe, Inc: The need for a higher pressure series of valves has been evident for at least five years, and the continuing trend to higher pressures and temperatures

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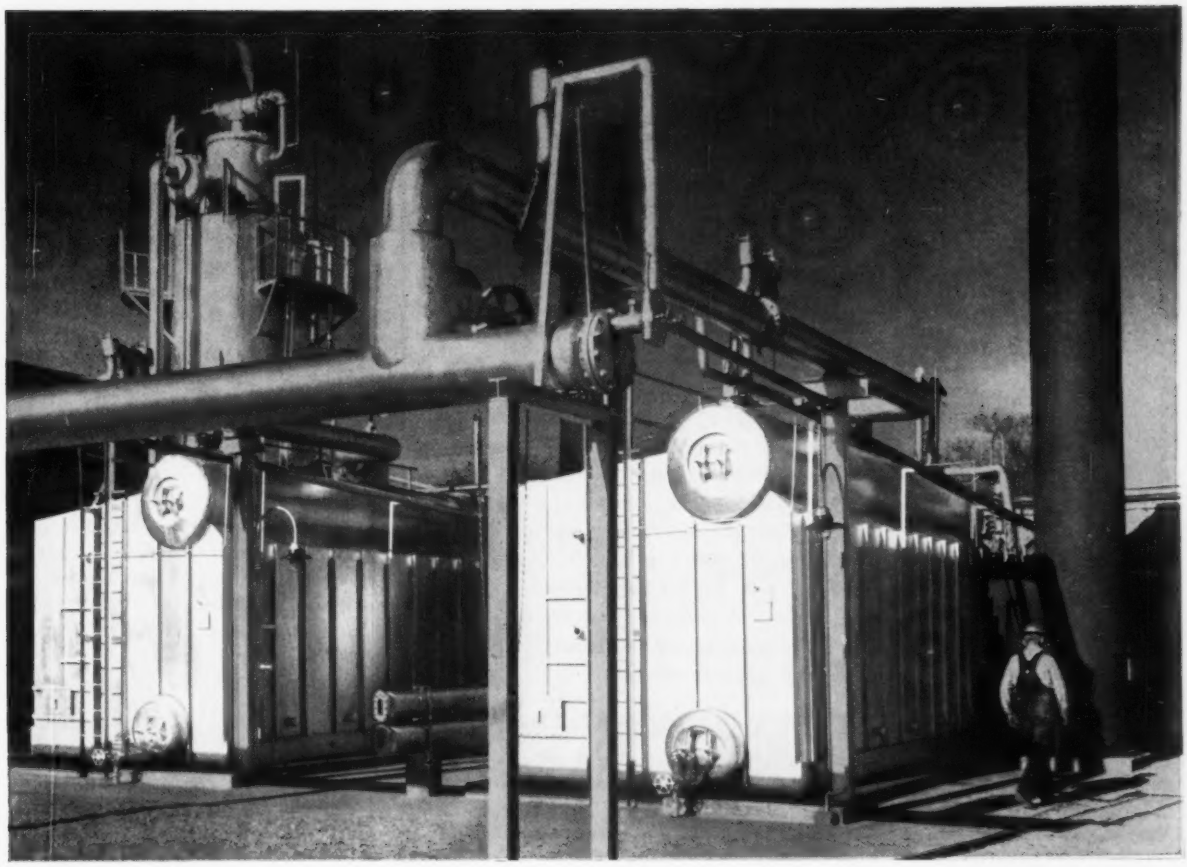

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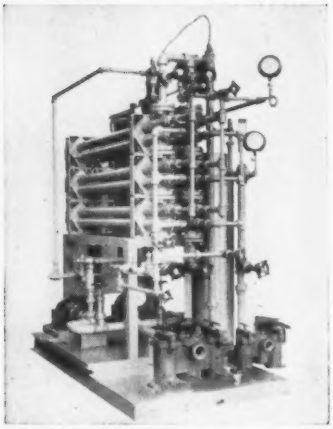

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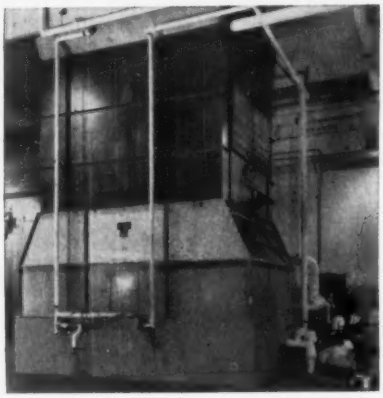

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Valve standard

Continued from page 206

makes such a series now almost mandatory. The 4500-psi series seems to be a very logical and appropriate one and I most heartily endorse Mr Crawford's suggestions.

H F BEHRENS, Commonwealth Associates, Inc: We believe that the ASA *Standards* should, and eventually will, be extended to cover valves above the present 2500 psi. We are in general agreement with the reasoning given in Mr Crawford's paper for setting this new standard at 4500 psi rather than 3000 or 4150 psi. . . .

There are many factors involved in the design of a valve for this extremely high pressure and one which is sometimes overlooked is the fact that even comparatively small valves can no longer be operated by hand because of the large stem diameter and the high internal pressure. This means that except for the rather small sizes, motor operation of some type is required.

In the table indicating the wall thicknesses . . . a valve with a port diameter of 13 in. has a wall thickness in the center of the body of 10¼ in. This is another argument for not installing a valve in the steam line between the boiler and the turbine. A valve thickness of this magnitude requires too long to heat and cool and is very susceptible to intergranular cracking. Our thought is that valves of this type should be limited as far as possible to the lower temperature installations.

B G HUME, Engineer of Steam Design, Department of Water and Power, The City of Los Angeles: The Department is not currently planning any central station installations that require valves with 4500-psi pressure ratings. . . . The trend in the power utilities is toward higher steam pressures and temperatures. . . . The 4500-psi standard for valves seems to fulfill the present-day requirements for higher-pressure steam plants.

Still other shades of opinion

E C GASTON, President, Southern Services, Inc: While we are very much interested in valves, better designs, etc, we have no experience with

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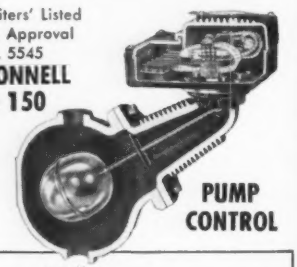

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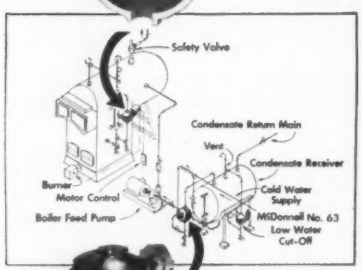

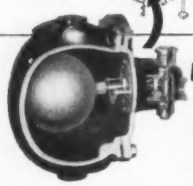

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Valve standard

Continued from page 208

critical-pressure designs nor are we currently contemplating such an installation. Two questions do arise, however; first, has the industry acquired sufficient experience at this time to establish the necessary design criteria, and second, does the demand exist for a standard and if so should it be 4500 psi or some other pressure? . . . It appears to us that it is appropriate to establish the allowable stresses and the design methods which would be applicable for any of the variable pressure-temperature conditions that are presently anticipated.

E L DAMAN, Deputy Director of Research & Engineering, Foster Wheeler Corp: I feel that there is no question of the desirability of having a 4500-psi standard, both for reasons of economy and convenience. Whether there is justification for extrapolating existing code design criteria is more than casually questionable. I do not mean to imply here that such extrapolation is unsafe, to the contrary it may be over-conservative.

R H SHANNON, Director, Nuclear Power Development Dept, United Engineers & Constructors Inc: With reference to specifying pressure-temperature ratings for 18-8 stainless steel, it now appears that this matter should be delayed awhile because of current questions about allowable-stress data for these materials at high temperatures. To my knowledge this includes the whole gamut of 18-8 stainless steels covering types 304, 309, 310, 316, 317, 321 and 347. . . In view of this it appears that there may be a question about the use of a plasticity factor for these materials (especially at elevated temperatures).

It will be of value in establishing a new high-pressure valve class to make some review of the use of various nondestructive testing techniques and evaluate any possible effects the results might have in establishing the pressure-temperature rating for these valves.

C A KELTING, Asst Division Engineer, Consolidated Edison Co of New York, Inc: This subject has been under study by Subcommittee 3 of

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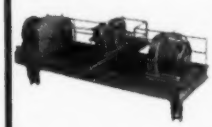

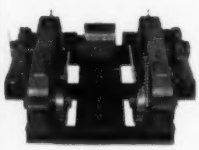

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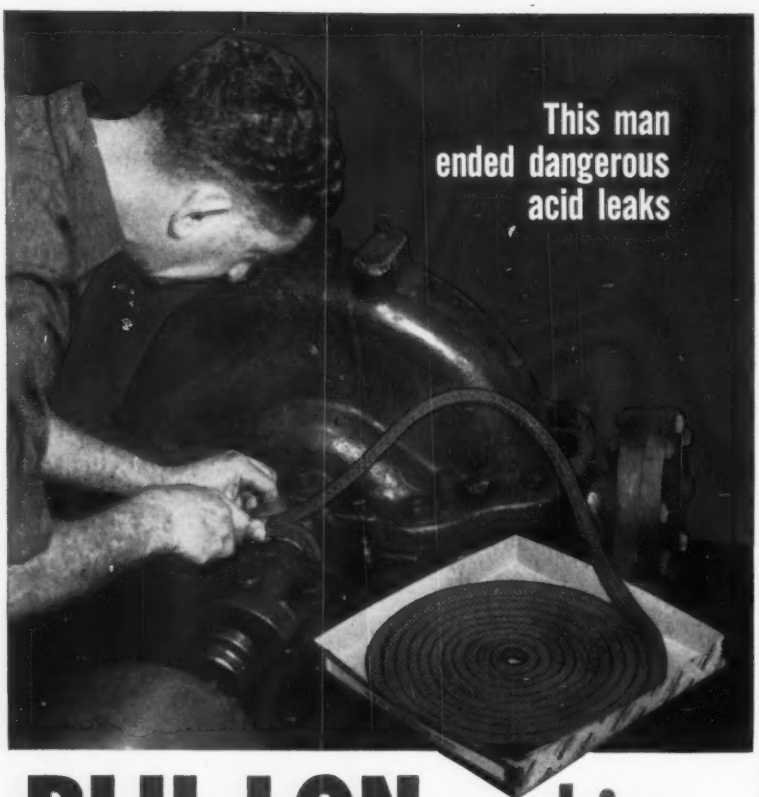

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Valve standard

Continued from page 210

ASA Sectional Committee B16 for about two years. A task group of which I am a member was asked to look into the addition of a new and higher pressure-rating series for ASA Standard B16.5. . . . We were directed to confine our work to ferritic materials although it appeared inevitable that stainless steels would have to be included. . . . The group tentatively proposed the 4500-psi series and recommended that the design for flanges, flanged fittings and valves be started. The Subcommittee, however, at its last meeting voted to pass this on for further study by the MSS (Manufacturers' Standardization Society of the Valves and Fittings Industry) since there was some feeling that possibly a 4500-psi series was not the most economical level to standardize. A somewhat different or possibly even two other pressure series might be more advantageous. We have not had their report on this as yet. . . . This article should help to stimulate activity along these lines. . . . It does limit design and pressure-temperature ratings to only valves having welding ends and pressure-seal or welded-bonnet joint construction. I believe, however, that it is the feeling of the Subcommittee that flange design should also be incorporated.

Mr Crawford replies

Continued from page 88

who have participated in the discussion.

It is interesting to note the many different views on the prospect of standardizing valves in the 4500-lb pressure class for power, petroleum, chemical and other high-pressure processes. One frequent suggestion has been that this pressure series might be too high. We think it worthwhile to point out that in the high-temperature range alloy steels lose their strength so rapidly that wide differences in allowable pressure actually represent rather small temperature changes. For example, the table in the December article for pressure and temperature showed that a proposed valve suitable for 4500 psi at 1050 F in ferritic alloy steel would be only good for 3350 psi at 1100 F. Hence, if the predominant power plant operating temperature were to

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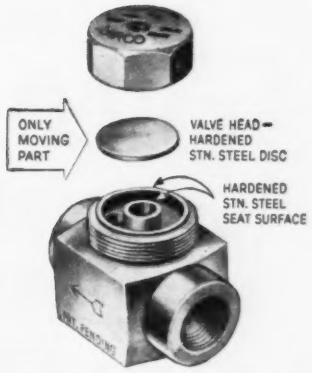

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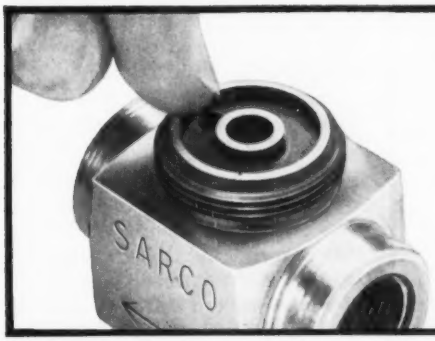
Operates perfectly on all loads . . . and when pressure fluctuates. Freeze-proof, when installed with outlet down. Highly resistant to superheat, water hammer, corrosive condensate.



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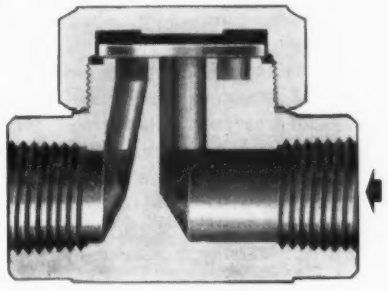

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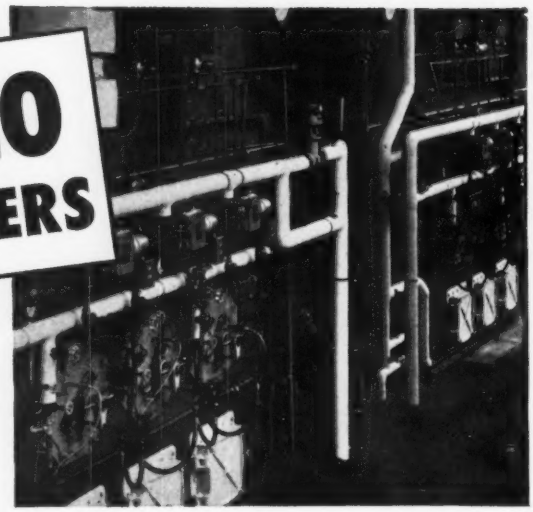

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Valve standard

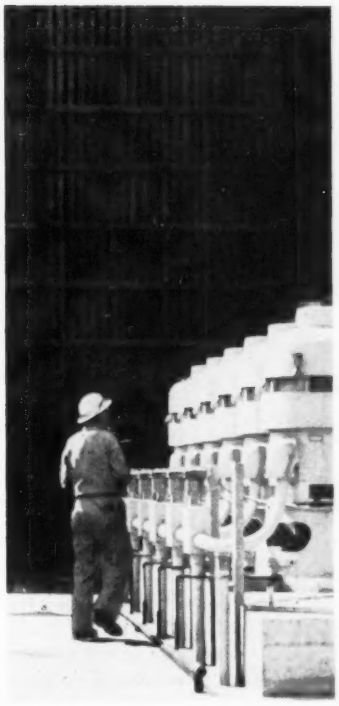
Continued from page 212

climb only a few degrees, the entire proposed pressure series would effectively become only a 3500-psi series.

Another point we think worth emphasizing along this line is the past history of valve pressure class standardization. Looking back at it now, it is apparent that too many different pressure classes were established, and that the industry and the user were burdened with a multiplicity in pattern and tooling cost. We have the example of the 400-psi class which has largely fallen into disuse, and the 900-psi class which is rapidly becoming a marginal series.

The economic penalty paid by a valve manufacturer, and user for each new pressure series is probably much greater than that paid by other component manufacturers. A pipe manufacturer has mainly to select an inside and an outside diameter for each new size and pressure class and provide the investment to process the design. A valve manufacturer makes a pattern or die for the outside contour, a corebox for an inside contour, a seat, a disk, a stem with each of its multiplicities of diameters and dimensions, a bonnet and its connection to the valve body, a stem packing mechanism, and a valve operating mechanism. Many man-hours of design, planning, pattern making and tooling must go into the initial manufacture of a new series of valves to make all of these various components. As a result of this, a large part of the economic cost of a valve in a new pressure series is in man-hours and planning, and only a small part is in material weight. As a consequence, any economic saving in material by the use of two pressure classes is frequently outweighed by the expenditure in man-hours in the development of the products. Likewise, the wage or salary and overhead costs in producing short run, new pressure series valves represent a major share of product cost.

The valuable comment in designing valves from the inside hole dimension to the outside points up what was probably a lack of clarity in our December article. One of the most important concepts of the proposed 4500-psi pressure class is the internal port diameter proposed for the 12 basic sizes. These diameters were



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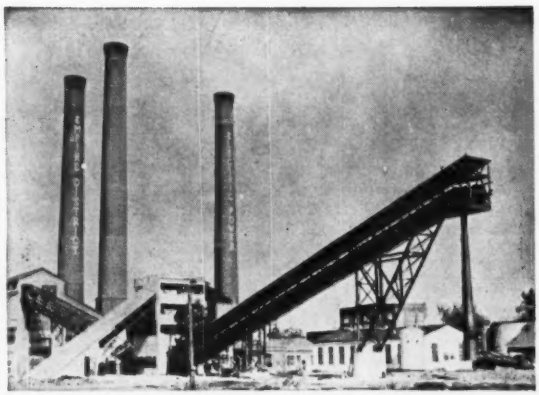

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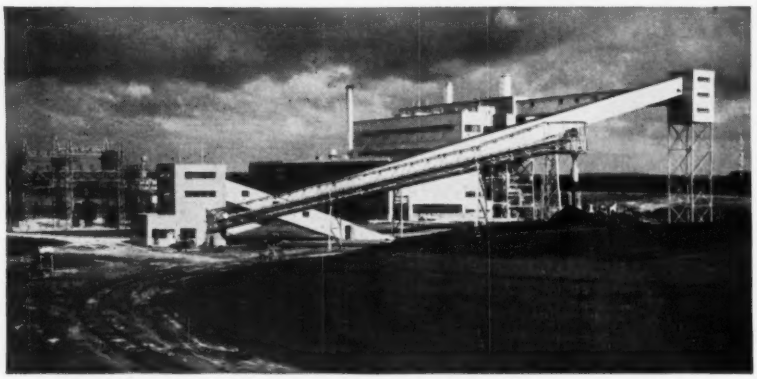

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Valve standard

Continued from page 214

carefully selected (using preferred number principles) so there is a uniform change in flow resistance between each of the 12 sizes. If a certain quantity of flow were to produce a pressure drop of X pounds in an 8-in. valve in this series, for example, the same quantity of flow would produce a pressure drop of .47 times X pounds in the 10-in. size. The same quantity of flow would produce 2.6 times X pounds pressure drop in the 6-in. size. These ratios are fairly constant throughout the proposed size range, except in the small forged-steel sizes. As was pointed out in some of the discussions, this is of advantage in matching valves to actual high-pressure high-temperature piping flow problems. Moreover, as we pointed out in the original article, this series of port diameters is not entirely arbitrary. They were selected so when the required wall thickness is built around the port diameter, one would not arrive at unusual outside diameters such as 7-in. pipe, 9-in. pipe, or something on that order. The table below shows the pressure drop progression for each of the proposed sizes.

Some of the discussors pointed out how extremely heavy the walls of these very large high-pressure valve castings will be. We can only say that we are also dismayed by this prospect, but the problems can be solved from both the engineering and economic standpoints.

Valve pressure drop progression

Nominal valve size, in.	Port diameter	Ratio-A	Ratio-B
¾ - 1	½	0.06	—
1½ - 2	1	0.014	16.0
2½ - 3	1⅜	0.21	7.0
4	2⅜	0.47	4.6
5	2⅞	0.34	2.1
6	3¾	0.39	2.9
8	4¾	0.47	2.6
10	5¾	0.45	2.1
12 - 14	7	0.42	2.2
16 - 18	8¾	0.43	2.4
20	10¾	0.47	2.3
24	13	—	2.1

Ratio-A: Pressure drop will *decrease* by this ratio when going to the next larger size.

Ratio-B: Pressure drop will *increase* by this ratio when going to the next smaller size.

Unretouched photo shows what happens when a boiler feed line is clogged with calcium carbonate deposits. CAUSE: *lack of chemical stability in feed water.* REMEDY: *properly balanced water treatment.*

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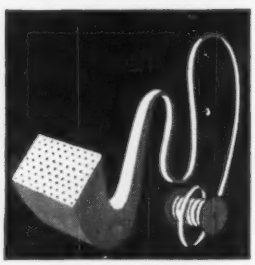

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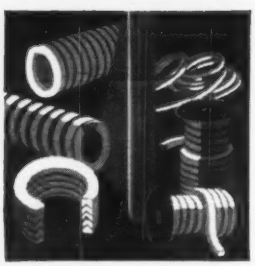

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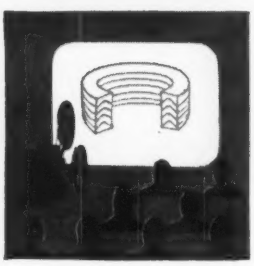

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for bulk fluids. Comes in 2½-, 3-, 4-in. sizes. Jordan Industrial Sales Div of OPW Corp, 6013 Wiehe Rd, Cincinnati 13, Ohio.

12 **Industrial lift,** said to be heaviest ever made with temporary rigging equipment, is subject of 8-p booklet. Contains photos, diagrams. The M W Kellogg Co, 711 3rd Ave, New York 17, N. Y.

13 **Case studies** of production, storage and shipping problems are treated in 26-p bulletin. Discusses use of hand-lift, fork-lift and "walkie" trucks. Lewis-Shepard Products Inc, Dept R-19, 125 Walnut St, Watertown 72, Mass.

14 **Car dumper,** rotary type capable of handling hopper and gondola cars, is described in 16-p illustrated brochure 957. Specs, diagrams, photos included. Heyl & Patterson, Inc, 55 Fort Pitt Blvd, Pittsburgh 22, Pa.

15 **Floating-roof tanks,** double-deck, pontoon and pan types, are treated in 4-p brochure 158. Includes photos, diagram, installation info. Nooter Corp, 1400 S 2nd St, St. Louis, Mo.

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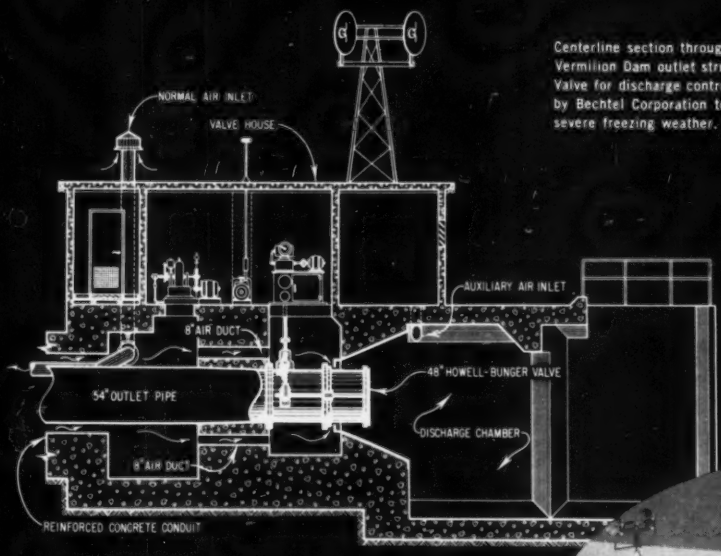
16 **Belting** for power transmission is subject of 10-p catalog. Contains photos, diagrams, maintenance data. Extremultus, Inc, 405 Lexington Ave, New York 17, N. Y.

17 **V-belt drives** to solve power-transmission problems are treated in 108-p book A661. Covers standard variable-speed and special-drive models, product and installation photos, engineering drawings, exploded views. Tables give hp capacities, belt speeds, etc. Dodge Mfg Corp, Mishawaka, Ind.

18 **Speed reducers,** double-reduction in ratios from 75:1 to 4900:1 are covered in 20-p catalog CD-230. Specs, photos, diagrams included. Cone-Drive Gears, Div of Michigan Tool Co, 7171 E McNichols Rd, Detroit 12, Mich.

19 **Silent chain drives** are subject of 88-p book 2425. Contains tables of service factors, ratings, chain length. Link-Belt Co, Dept PR, Prudential Plaza, Chicago 1, Ill.

(*Continued on page* 220)



Centerline section through Southern California Edison Company's Vermilion Dam outlet structure shows 48-inch SMS Howell-Bunger Valve for discharge control. It is mounted in a chamber designed by Bechtel Corporation to minimize spray, erosion, and icing in severe freezing weather.

Valve discharging approximately 800 cfs at full gate has caused no noticeable erosion to channel in three years operation. Southern California Edison Company's Vermilion Dam and reservoir is on Mono Creek in the Sierra Nevada of California. At the Company's Portal Powerhouse on Huntington Lake, Calif., a 90-inch SMS Howell-Bunger Valve also operates under severe winter conditions by remote control.

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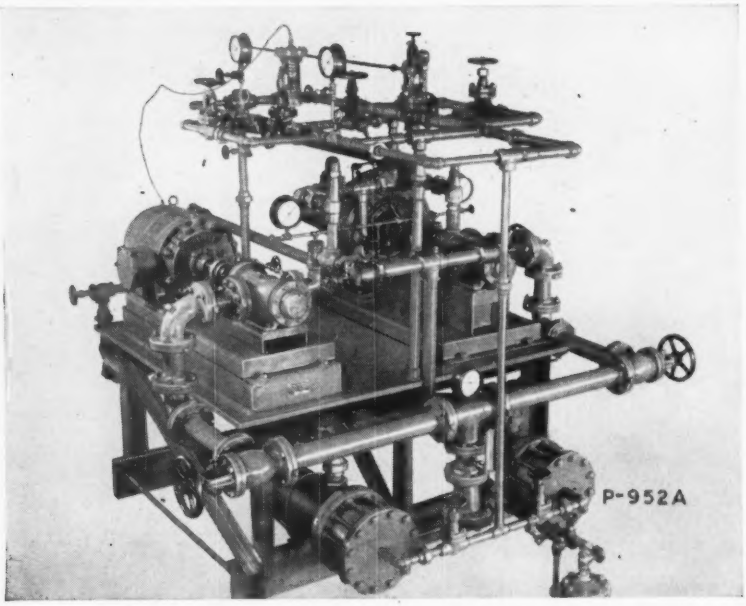

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Free literature

Begins on page 163

METALS AND ALLOYS

20 **Corrosion resistance** of copper and copper alloys is topic covered in 32-p reference booklet B-36R. Includes tables, photos. The American Brass Co, Waterbury 20, Conn.

21 **Liquid metal system** components are discussed in bulletins GEA-6453A, 54A, 56A, 57A, 60A, and 95A. Components are designed for use in the nuclear, metallurgical, petroleum and chemical fields. General Electric Co, Schenectady 5, N. Y.

22 **Magnesium** and aluminum alloys are listed in 20-p catalog 57. Includes properties, specs; alloys for sand castings, permanent-mold, rare-earth alloys. Wellman Bronze and Aluminum Co, 12800 Shaker Blvd, Cleveland 20, Ohio.

23 **Better casting guide** is 32-p pamphlet. Contains data on factors influencing production of sound zinc-alloy die castings, causes and prevention of defects in castings. Henning Bros & Smith, Inc, 91-127 Scott Ave, Brooklyn 37, N. Y.

24 **Titanium tubing,** present status and future potential, is subject of 8-p reprint TR-550. Discusses production, characteristics. Babcock & Wilcox Co, Tubular Products Div, Beaver Falls, Pa.

METERS AND INSTRUMENTS

25 **Frequency-measuring** devices for 400-cps power sources are listed in 8-p booklet. Contains pictures, descriptions, specs. Varo Mfg Co Inc, 2201 Walnut St, Garland, Texas.

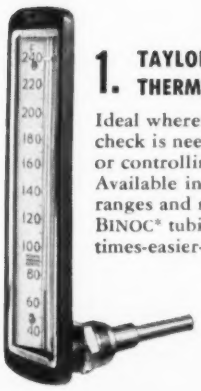
26 **Potentiometers,** precision types, are subject of 28-p catalog GR107. Descriptions, diagrams, specs given for 10 models, plus engineering data. George Rattray & Co, Div of Hardwick, Hindle Inc, 116-08 Myrtle Ave, Richmond Hill 18, N. Y.

27 **Controls,** flow and liquid level, and their use at Experimental Boiling Water Reactor are subject of 10-p booklet. Control applications to atomic and more conventional power sources described. Magnetrol, Inc, 2110 S Marshall Blvd, Chicago 23, Ill.

28 **Liquid-level gages** are discussed in 48-p catalog 36. Lists models with photos, diagrams, specs; includes engineering data and accessories. Penberthy Mfg Co, 1242 Holden Ave, Detroit 2, Mich.

29 **Gages, thermometers,** instruments and controllers are described in 6-p bulletin 3010. Lists units briefly, offers catalog on each for full info.

SIX WAYS to CUT COSTS with *Taylor Instruments*



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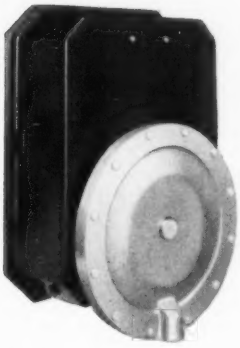

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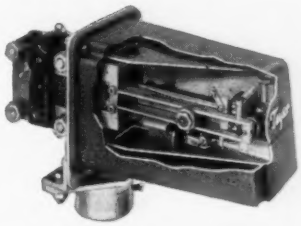

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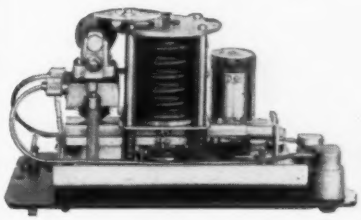
A rugged, dependable and accurate instrument designed to measure flow, liquid level or specific gravity. Taylor's lastest addition to TRANSET* System of transmitters, receivers and controllers.



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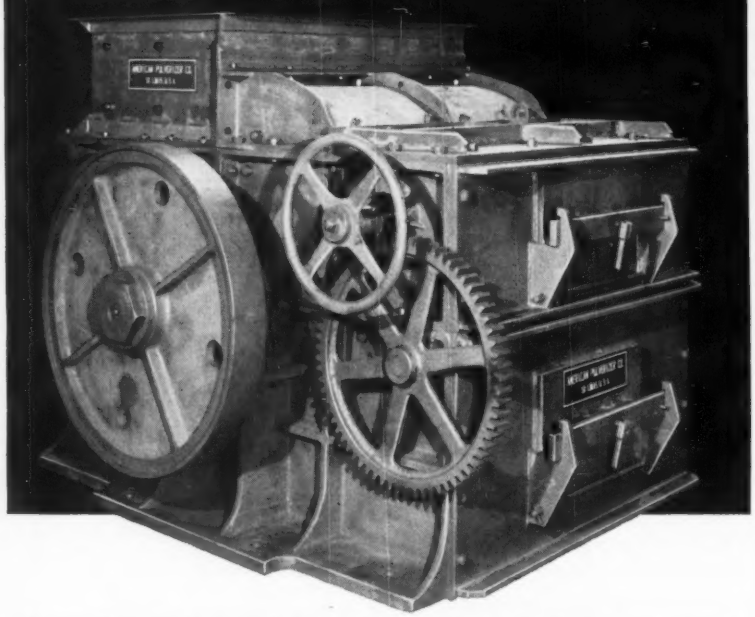

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Free literature

Begins on page 163

United States Gauge, Div of American Machine & Metals, Inc, Sellersville, Pa.

PIPING, VALVES, FITTINGS AND SPECIALTIES

30 **Gaskets,** spiral-wound metal types, are subject of 12-p bulletin AD-104. Describes features, design factors. Includes photos, cross-sections, graphs and specs. The Garlock Packing Co, 415 Main St, Palmyra, N. Y.

31 **In-plant photos** of three types of bending are featured in 36-p booklet. Describes rotary, ram and roll bending. Wallace Supplies Mfg Co, 1300 Diversey Parkway, Chicago 14, Ill.

32 **Asbestos packing** and gaskets are topics covered in 8-p bulletin. Lists 120 chemicals that can be handled by gaskets, includes tables of stock sizes, dimensions. Durabla Mfg Co, 114 Liberty St, New York 6, N. Y.

33 **Vacuum valve design** is topic of 2-p data sheet. Drawings and dimension chart included. Vacuum Research Co, 420 Market St, San Francisco 11, Calif.

34 **Hot-pipe insulation** for underground application is described in 12-p folder Z-1. Contains sequence photos, diagrams of cast-in-place monolithic conduit system. Z-Crete Div, Zonolite Co, 135 S LaSalle St, Chicago 3, Ill.

MISCELLANEOUS

35 **60th Anniversary** of company inspired 24-p booklet. Growth, history of oiling-device manufacturing company is graphically described. Wm W Nugent & Co Inc, 3440 Cleveland St, Skokie, Ill.

36 **Vertical transportation** equipment from autotronic elevators to escalators is described in 32-p illustrated catalog. Layout drawings for 14 elevators included. Otis Elevator Co, 260 11th Ave, New York 1, N. Y.

37 **Insulation jacketing** materials and methods are discussed in 40-p booklet. Contains photos, application diagrams, appendices covering specs, properties, tips on handling. Kaiser Aluminum & Chemical Sales, Inc, 919 N Michigan Ave, Chicago 11, Ill.

38 **Accessories and supplies** for industrial instruments are listed in 60-p catalog 500. Includes specs, photos and drawings, part numbers for items including pressure-gage and flowmeter accessories, bushings and flanges, thermocouples. The Foxboro Co, Foxboro, Mass.

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SURFACE
Treated with elastomeric binder and powdered graphite . . . serves as a surface leveling and friction reducing element.

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90% asbestos yarn reinforced with 2 strands of inconel wire for corrosion resistance as well as maximum heat resistance.

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Long fiber asbestos, graphite, and a corrosion inhibitor all bonded together in a way which assures flexibility.

NEW valve stem packing . . . STYLE 127 for high pressure, high temperature Service

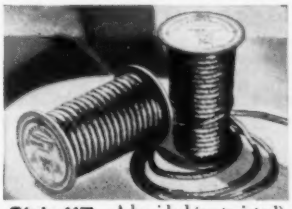
Here's an outstanding valve stem packing which is ideally suited to extreme steam conditions. Withstands pressures of 4000 psi., and steam temperatures to 1200°F. as long as stuffing box itself does not exceed 750°F. It is unsurpassed as a high temperature oil refinery or steam power plant packing.

This Style 127 Valve Stem Packing is the newest member of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals to meet all your needs. It's the only complete line. That's why you get unbiased recommendations from your Garlock representative. Call him . . . ask about the new Style 127.

OTHER GARLOCK VALVE STEM PACKINGS

Style 5855—Similar to 127, but for lighter duty. Costs less, too.

Style 17—A braided asbestos yarn treated to resist steam at high pressures and temperatures to 600°F.



Style 117—A braided (or twisted) asbestos yarn treated for service against steam at low to medium temperatures.

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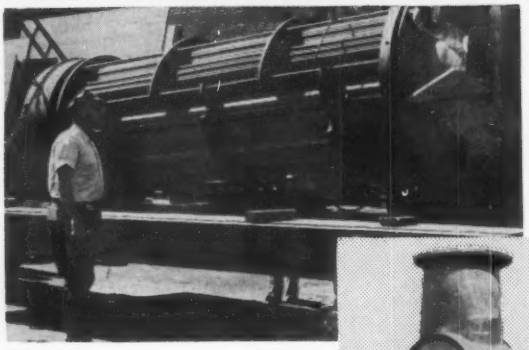
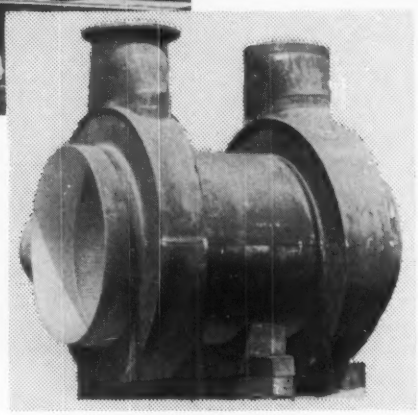


FOR TUBULAR EQUIPMENT



1 ABOVE—*A high pressure heater for feedwater, retubed by CONSECO and on its way back to PHILADELPHIA GAS & ELECTRIC.*

2 RIGHT — *Special CONSECO Heat Exchanger, aluminum sprayed interior, and calorized tubes. FOR GENERAL CHEMICAL COMPANY.*

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COMPLETE BULLETINS SENT ON REQUEST

Reports from the field

Begins on page 150

could break down under radiation. There could be no penetration of reactor shell, and no bonding agent could be used to give dimensional stability.

Reactor vessel was encased in sections of 4-in. thick glass fiber with light hexagonal wire netting on inside surfaces, wire mesh on outer surfaces. Worker safety precautions included thick protective coatings of preformed insulation with high-temperature binder for instrument ports and adjacent piping, air-conditioned control room insulated with fibrous glass faced with aluminum foil.

Glass was also used to leakproof nuclear fueling canals—four pits 25-ft square, 30- to 40-ft deep to which atomic fuel can be transported by remote control for storage under water if fuel change becomes necessary. Nuclear reactor was designed and developed by Westinghouse Electric Corp for the Shippingport plant operated for AEC by Duquesne Light Co of Pittsburgh. It heats high-pressure water which is piped through heat exchanger, turning second supply of water into steam to drive a 100,000-kw turbine-generator. Owens-Corning Fiberglas Corp supplied insulation.

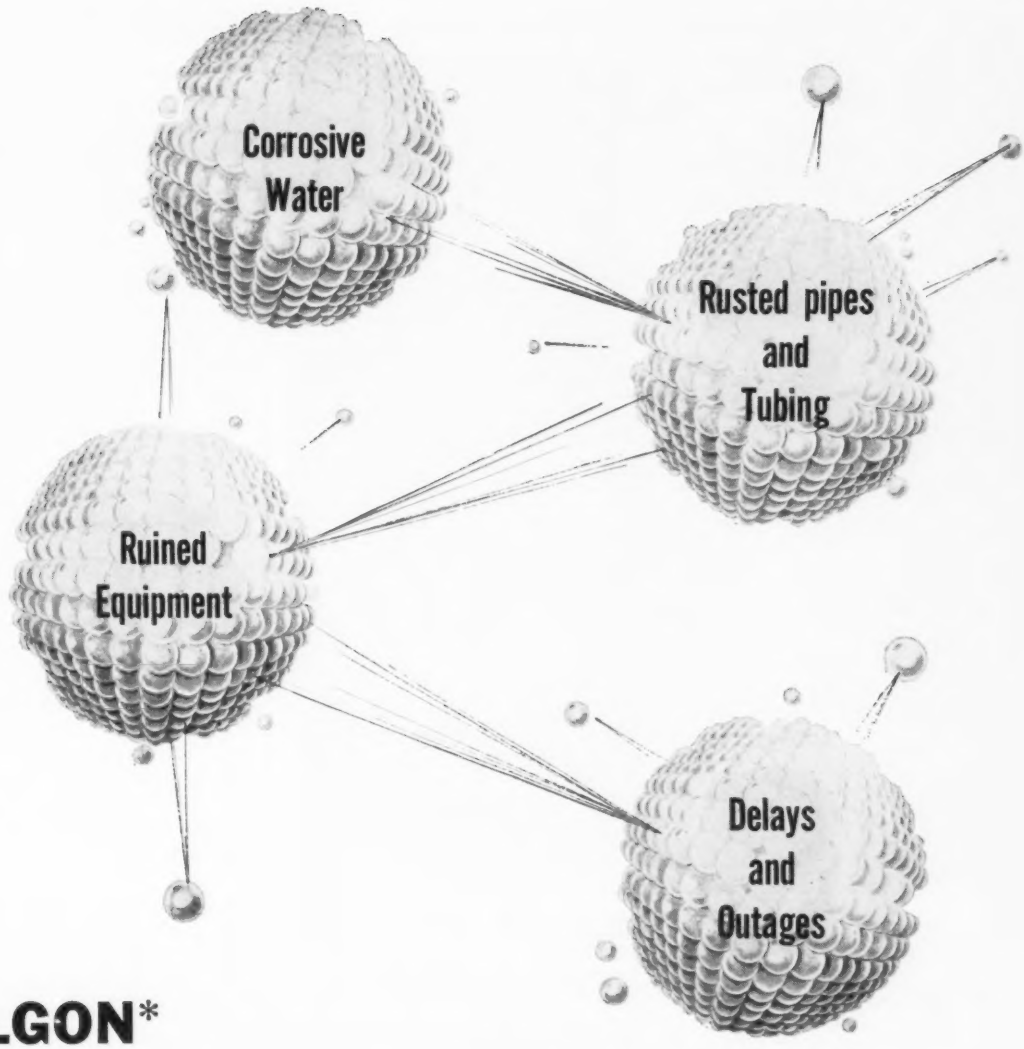
Calendar of Events

Feb 24-28 — American Institute of Mining, Metallurgical and Petroleum Engineers Inc, Annual Meeting. Jung Hotel, New Orleans, La. Details from AIME, 29 W 39th St, New York 18, N. Y.

Feb 24-28—American Society of Civil Engineers, National Convention. Hotel Sherman, Chicago, Ill. Details from ASCE, 33 W 39th St, New York 18, N. Y.

March 3-6—American Society of Mechanical Engineers, Gas Turbine Power Div, Conference and Exhibit. Shoreham Hotel, Washington. Details: Barry Freer, 1300 Connecticut Ave, NW, Washington 6, D.C.

March 11-13 — Instrument Society of America, Eighth Annual Conference on instrumentation for



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stops the chain-reaction costs of

CORROSION in WATER SYSTEMS

Corrosion in any part of a cooling or process water system can touch off a chain reaction of damage and costly delay. Repair or replacement of equipment plus production losses far exceeds the cost of adequate protection against corrosion damage.

To avoid costly damage, call on Calgon Engineering Service. Protection for the entire system, from cooling towers on through, is set up. Iron and steel surfaces can be given fast and more complete protection with Calgon* composition TG, remarkable for its accelerated film forming ability. Copper or copper alloy corrosion can be inhibited with Coraid, which is effective at both high and low pH values.

Experience with all types of industry in all parts of the country is at your disposal; a letter or phone call will put a Calgon engineer to work on *your* problem.

*Calgon is the Registered Trademark of Calgon Company for its sodium phosphate glass (sodium hexametaphosphate) products. The use of Calgon for the prevention of corrosion is covered by U.S. Patent 2,337,856.

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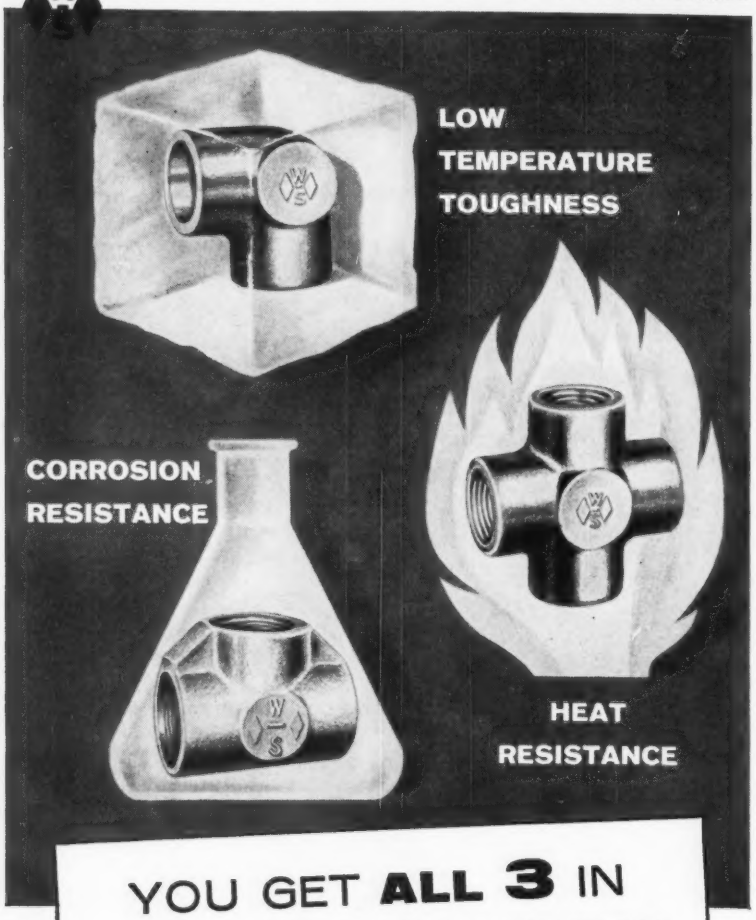
THE DOUBLE DIAMOND ASSURES DOUBLE VALUE



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When corrosion is a troublesome factor in processing—at high temperatures or low—specify W-S 150 lb. Stainless Steel Fittings and eliminate a major cause for piping equipment failure. W-S 150 lb. fittings are available in stainless steel types 304 and 316... with screw ends or welding sockets... in sizes ⅛" to 4"... and as elbows, tees, crosses, couplings, half couplings, reducers, caps, plugs, bushings and unions.

Triple-service W-S fittings of this type are lightweight and exceptionally strong. They're your safeguard in petroleum, chemical, petrochemical, food and other process operations.

For technical information, write today for Bulletin S-3.

WORKING UNDER PRESSURE? W-S HAS A FITTING ANSWER. W-S manufactures a full range of high quality drop forged fittings, unions and couplets... in carbon, stainless and alloy steels. For full information about these products, or for your commercial forging and die casting requirements, write to: Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.

H. K. PORTER COMPANY, INC.

FORGE AND FITTINGS DIVISION

Reports from the field

Begins on page 150

the iron and steel industry. Roosevelt Hotel, Pittsburgh. Details from Frank K Briggs, Westinghouse Electric Corp, Atomic Power Div, Large, Pa.

March 17-21—National Assn of Corrosion Engineers, 14th Annual Conference. Civic Auditorium, San Francisco, Calif. Details from NACE, 1061 M & M Bldg, Houston 2, Texas.

March 17-21 — International Atomic Exposition, Inc, in conjunction with **1958 Nuclear Congress,** Atomfair of the Atomic Industrial Forum. International Amphitheatre, Chicago, Ill. Details from Gray & Rogers, 12 S 12th St, Philadelphia 7, Pa.

March 19-20—American Society of Mechanical Engineers in conjunction with **American Institute of Electrical Engineers,** Engineering Management Conference. Hotel Somerset, Boston, Mass. Details: ASME, 29 W 39th St, New York 18, N. Y.

March 26-28 — Illinois Institute of Technology, 20th Anniversary Meeting of American Power Conference. Hotel Sherman, Chicago. Details: R A Budenholzer, mechanical engineering dept, IIT, 3300 Federal St, Chicago 16, Ill.

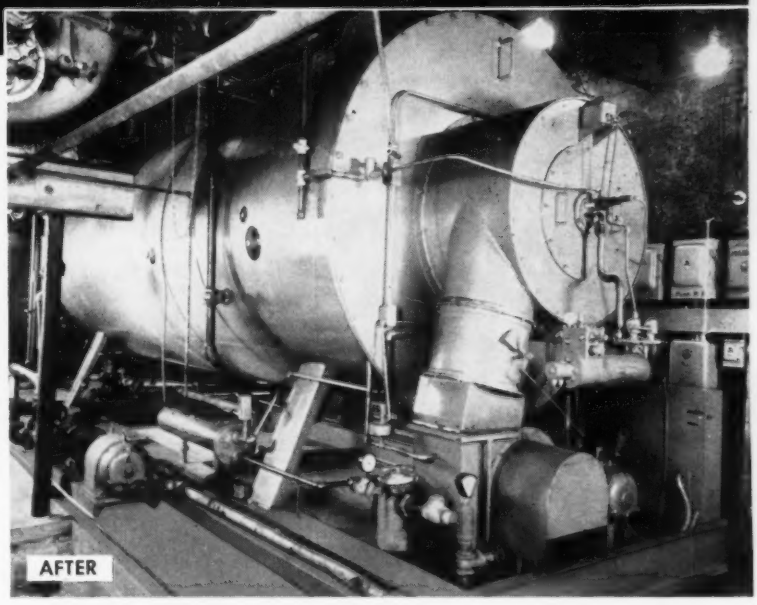
March 27-29—Electrical Maintenance Conference. Shrine Exposition Hall, Los Angeles, Calif. Details from Fred J Tabery, 3443 S Hill St, Los Angeles, Calif.

Cathodic protection gains wide acceptance

As a method of combating metal corrosion, cathodic protection has advanced from a curiosity to a standard accepted method in the past few years, stated B Husock of Harco Corp in a paper presented to the American Institute of Electrical Engineers. Major development has been "increased scope of activity in the field." Application of process to underground pipelines has achieved especially good results. "It is not unreasonable to assume that the useful-

"THIS YORK-SHIPLEY GENERATOR SAVES US $100 EVERY OPERATING DAY."

One of the 150-HP units used before the York-Shipley Installation.



Efficient 500 H.P. high pressure York-Power Steam-Pak firing heavy oil installed by Allied Oil Burner Co., Paterson, N. J.

YORK-POWER Automatic Packaged Boiler brought calculated savings in operating costs and produces better quality steam

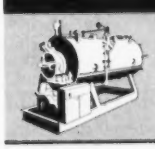
Lew Shaffer, president of the Reliable Dyeing and Finishing Company of Paterson, N. J., now is a man who knows there's no percentage in fussing with outmoded and inefficient boilers. He is also an enthusiastic booster for York-Power Automatic Steam-Pak Boilers . . . and here's why:

This plant formerly operated three 150-H.P. units (two oil and one coal-fired). These units were inefficient. Coal, oil and operating costs were high. Brickwork was in bad shape and the stack needed costly repairs.

So, something had to be done . . . but fast! And, that was where the York-Power Automatic Steam-Pak came into the picture. Not only was this unit quickly and easily installed but, says Mr. Shaffer, "we figure it saves us $100 per day in direct costs over our old set up through more efficient operation. The high uniformity and quality of steam allows uninterrupted machine operation with indirect saving due to elimination of stoppages and spoiled material."

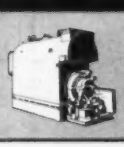
York-Power Automatic Boilers can save you money and improve your processing operations. This installation more than paid for itself the first year. Investigate York-Power's Lease plan. No down payment required. There's a York-Shipley representative in your community who is ready to cooperate with you in every way possible. Call him today or send the coupon today for more information.

Industrial Division **YORK-SHIPLEY, Inc.** YORK, PA.

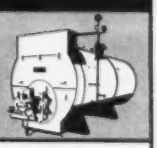


STEAM-PAK
15 to 600 Hp.
Oil and/or Gas Firing

PAKETTE
10 to 50 Hp.
Oil and/or Gas Firing



FIRE-PAK
35 to 485 Hp.
Oil and/or Gas Firing



SCOT-PAK
52 to 400 Hp.
Oil and/or Gas Firing

Industrial Division York-Shipley, Inc. York, Pa.
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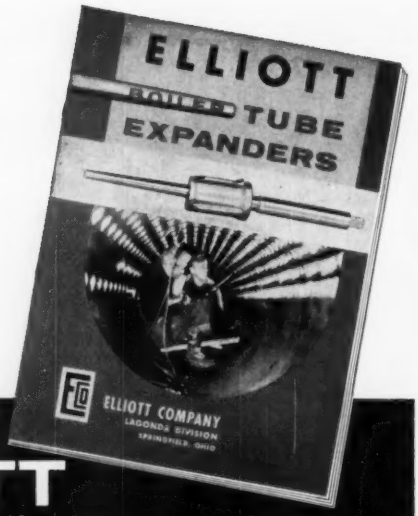
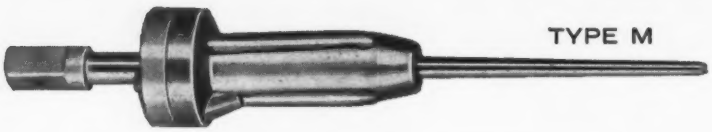


ELLIOTT
Boiler Tube Expanders
for tubes 3/4 in. I.D. and up


TYPE M

TYPE K

This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A new heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

RIGHT-ANGLE GEAR DRIVE▸
Available in ½, ¾ and 1-in. sizes

Write the Elliott Company, Lagonda Division, Springfield, Ohio, *today*, for your copy of Bulletin Y-46.

Y7-5

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For Tube Cleaners, Expanders and Accessories

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

Reports from the field

Begins on page 150

ness of cathodic protection will continue to expand and that new refinements and techniques will increase its ability to reduce our large corrosion costs," Husock concluded.

• • •

Development of an impressed-current cathodic-protection device to permanently protect propellers against corrosion, increasing their useful lives and cutting repair costs, has been announced by Charles Engelhard Inc. Automatic electrical system may make possible use of steel propellers. Steel is stronger and cheaper than standard bronze, but has been impractical because of corrosion susceptibility.

Applications would include tidal hydroelectric turbines, pipelines carrying sea water for cooling to oil refineries and steam plants. Corrosion is caused by flow of chemically created electricity through salt water; system is said to neutralize this flow with reverse current emanating from platinum anodes attached to hull at strategic points, but insulated from it.

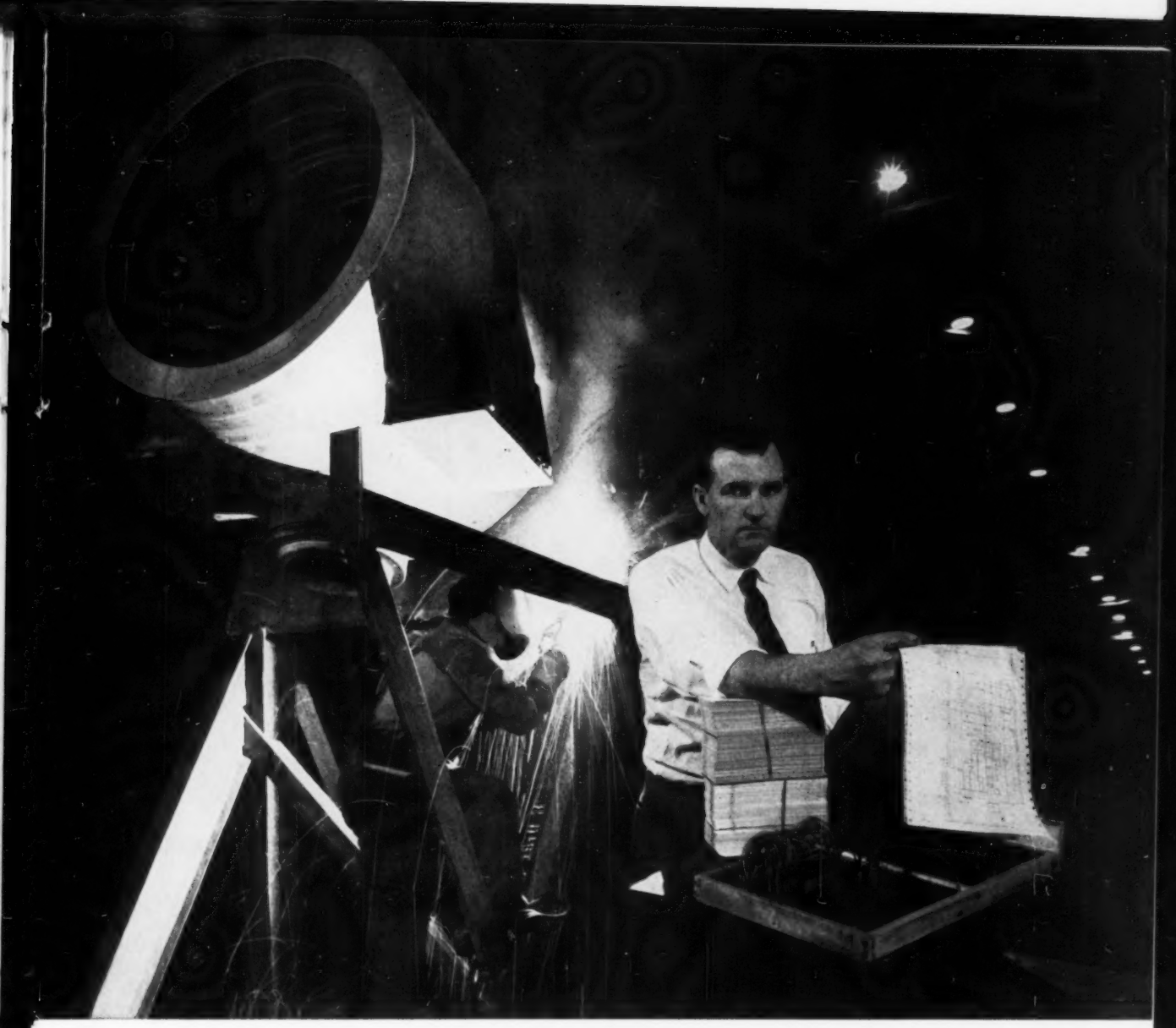
Power goes underground in Italian, Japanese plants

Design and construction of power plants now includes atom-bomb protection, according to three Italian engineers. Drs Carlo Semenza, Dante Finzi and Mario Mainardis reviewed development of underground power stations in Italy in a paper recently presented before the American Society of Civil Engineers.

Italy currently has 57 underground power stations of 10,000-kw capacity or more. Installed capacity is now higher than that of outdoor stations and 4,500,000-kw capacity is expected by 1960. First stations went underground for avalanche protection, then for strategic reasons before and during World War II. Postwar development has stressed safety factor of a layer of compact rock in case of atomic attack.

• • •

Possible underground location of Japanese power will be largely influenced by seismatic considerations report civil engineers Tatsuo Mizukoshi and S Mimura. Earthquakes



Automatic data processing, applied to the many variables of thermal design, results in higher efficiency of ALCO *feedwater heaters.*

HOW DO YOU FIGURE A FEEDWATER HEATER?

The trend to higher pressure and temperature in utility and industrial power plants demands *exact* design of feedwater heaters for the best heat-rate economy. ALCO, a 30-year pioneer in the heat transfer field, is again pacing the industry by focusing thermal engineering on solutions to this problem.

Advanced data on heat transfer and fluid flow from ALCO's new thermal laboratory, programmed through new electronic digital and analog computers, permits ALCO to offer the most accurate feedwater-heater thermal designs available today. Already in service and on order for the country's most efficient steam-generating plants, these heaters are proving their economy and reliability.

For more information, contact your nearest ALCO sales office or write for brochure on feedwater heaters to: ALCO Products, Inc., Dept. 132, Schenectady, New York.

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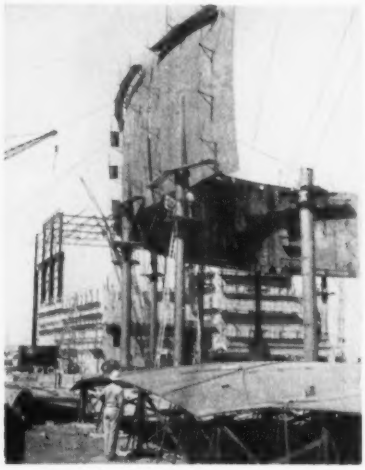
PEABODY LIMITED • LONDON, S.W. 1, ENGLAND

Reports from the field

Begins on page 150

are an ever-present threat in Japan, and new Sudagai project was built completely underground to test insulating effect of *terra firma*. Plant was completed in 1955, and engineers expect advantages in terms of lowered construction costs as well as earthquake protection.



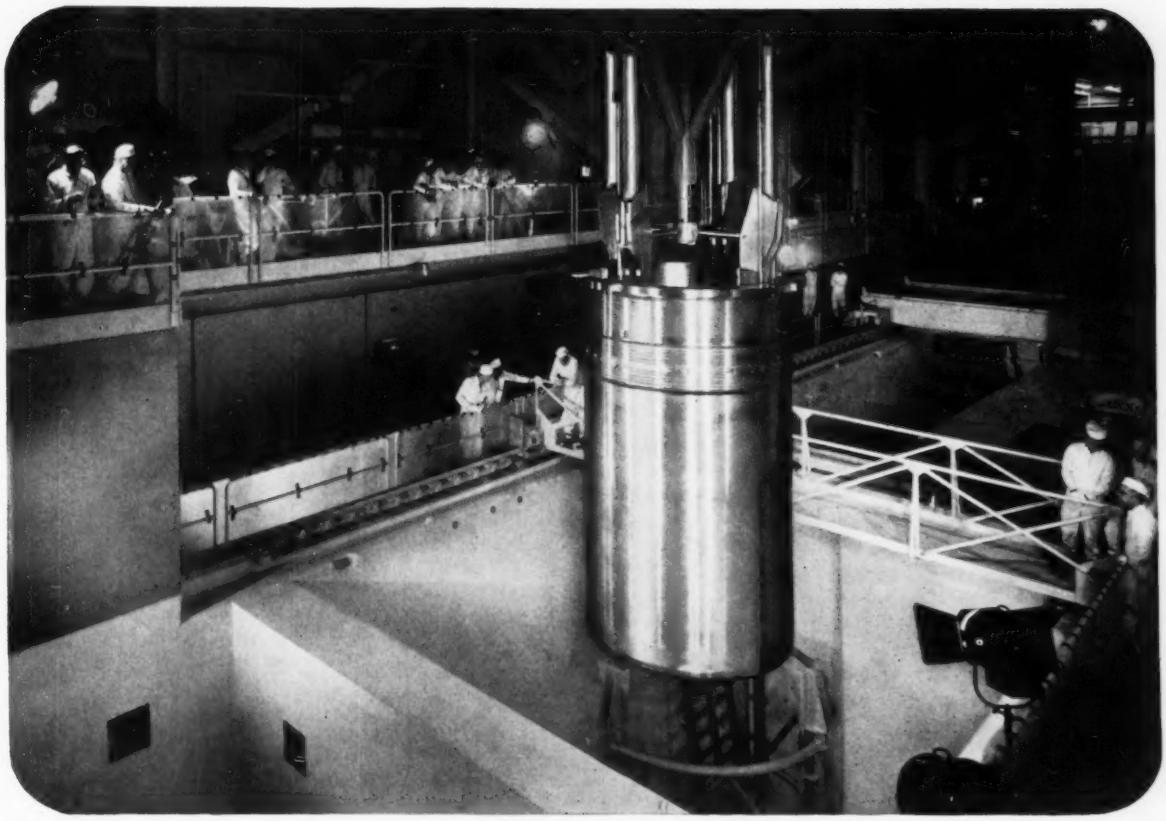
Largest U.S. reactor going up in Illinois

Sections of a 190-ft steel sphere are being welded into place at the site of Commonwealth Edison Co's 180,000-kw Dresden Nuclear Power Station. Station is located on the Illinois waterway 50 miles southwest of Chicago. Sphere will contain plant's boiling water reactor.

Station, scheduled for completion in 1960, is being built by General Electric Co for a contract price of $45 million. Associated in the project with Commonwealth in paying $15 million of the cost as a research and development expense are American Gas and Electric Service Corp, Bechtel Corp, Central Illinois Light Co, Illinois Power Co, Kansas City Power & Light Co, Pacific Gas and Electric Co and Union Electric Co.

Power piping systems for four TVA steam power plants will be supplied by Power Piping and Sprinkler Div of Blaw-Knox Co. Contract is valued at $3,500,000. Piping will be 2¼% chromium, 1% molybdenum steel 14-in. OD. First unit is scheduled for completion this year.

ION EXCHANGE RESINS for water conditioning



The water which shields and surrounds this nuclear core is deionized by AMBERLITE Monobed ion exchange resin units.

At the SHIPPINGPORT ATOMIC POWER STATION—where water conditioning must be efficient...dependable...fool-proof—AMBERLITE Ion Exchange Resins are used.

In this plant, built jointly by the Duquesne Light Company and the United States Atomic Energy Commission, water is the medium through which atomic energy ultimately becomes electrical energy. But this water must be completely mineral-free (1) to reduce the hazard of its metallic ions becoming radioactive and (2) to minimize "scale" formation in this plant's vital piping and heat exchange systems. For this reason, the plant's water conditioning equipment uses Rohm & Haas' AMBERLITE ion exchange resins.

After preliminary treatment of the water, calcium and magnesium ions are removed by two softening tanks containing AMBERLITE IR-120 cation exchange resin. The water then goes to a mixed bed deionization unit of AMBERLITE Monobed resin (a mixture of AMBERLITE IR-120 and IRA-400) which removes both anions and cations. The water is now ion-free. Possible pick-up of metallic ions and their build-up is controlled by passing part of the water used in the plant's primary loop through a separate mixed bed ion exchange unit containing AMBERLITE XE-154 (a specially prepared mixture of AMBERLITE IR-120 in the lithium form and AMBERLITE IRA-400 in the hydroxyl form) which raises the pH well above neutrality as a safeguard against corrosion.

For additional protection against the hazard of "hot" metallic ions, the water surrounding and shielding the reactor's core is deionized by Monobed ion exchange resin units containing AMBERLITE XE-150.

Whatever your water conditioning problem, your engineering company specializing in water conditioning is qualified by experience to recommend how AMBERLITE resins can best serve your special needs. For detailed information about AMBERLITE resins, write for our booklet *"If You Use Water."*

AMBERLITE *is a trade-mark, Reg. U.S. Pat. Off. and in principal foreign countries.*

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THE RESINOUS PRODUCTS DIVISION

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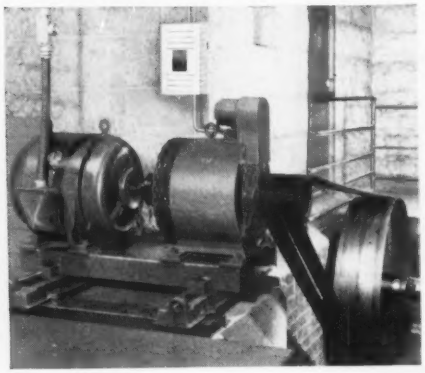
GOT A SPEED CONTROL PROBLEM?

HERE'S HOW OTHERS SOLVE IT THEMSELVES WITH E-M AMPLI-SPEED DRIVE

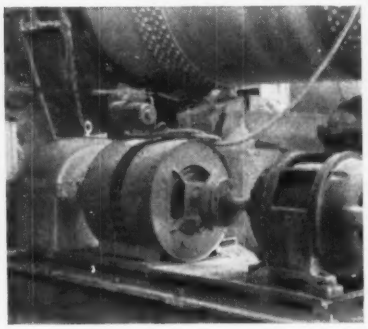


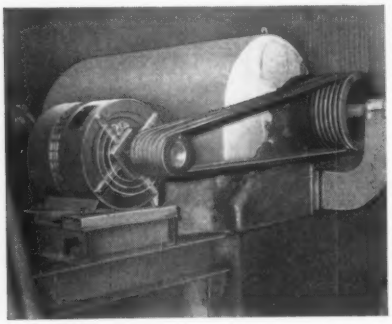
SOLVES VENTILATING FAN DILEMMA

Problem: When power in a large Minnesota building was converted from d.c. to a.c., five giant ventilating fans, formerly powered by adjustable speed d-c motors, had to have new a-c drives. **Solution:** They installed induction motor-driven E-M Ampli-Speeds. **Result:** A low-cost change-over plus a definite power saving advantage. The fans are controlled at speeds of 0-170 rpm.

IMPROVES CEMENT KILN OPERATION

Problem: Operators of a California cement plant wanted to adjust revolving cement kiln speed accurately for highest quality output. But speed of installed wound-rotor motor could only be changed in steps. **Solution:** The company replaced it with an E-M Ampli-Speed Magnetic Drive coupled to an existing induction motor. **Result:** Exact, smooth speed control over a wide range; higher quality cement; and increased output.





PERFECTS PAINT MAKER'S CENTRIFUGE

Problem: To separate various sized particles of pigment, a Georgia paint manufacturer varied his centrifuge speed with an adjustable pulley device. But the speed still tended to "drift" and made accurate particle separation impossible. **Solution:** He replaced the pulley device with Ampli-Speed. **Result:** Stepless, pin-point control of centrifuge speed between 190-640 rpm, giving accurate particle separation. Drifting is held to ±2% by Ampli-Speed's automatic speed control system.

DO IT YOURSELF WITH AMPLI-SPEED

Remember, you don't need costly engineering or factory technicians to install Ampli-Speed. Your own plant electrician can do it.

E-M

Write the factory now for informative literature showing how Ampli-Speed can solve your speed control problem. Ask for Bulletin 1126.

4400-TPA-2191

ELECTRIC MACHINERY MFG. COMPANY

Minneapolis 13, Minnesota

Somewhere in your plant an operation can be improved with smooth, adjustable Ampli-Speed Drive

Today's gears

Continued from page 119

Worm gear lubricants need wear- and friction-reducing materials under normal conditions. "Cylinder" oils containing suitable percentages of fatty compounds supply this need.

Some heavily-loaded hypoid gears require strong E.P. activity. Various additive combinations are used including phosphorus, sulfur, chlorine, and fatty compounds.

Water-separating ability. All gear sets are subject to water contamination by condensation from the atmosphere, and many receive water from other sources such as oil coolers. Water causes rusting and tends to form emulsions. With dirty or oxidized oil, the emulsions tend to become permanent and to thicken by combining with dirt. The resulting sludge can foul oil passages and restrict oil flow. Gear and bearing wear result.

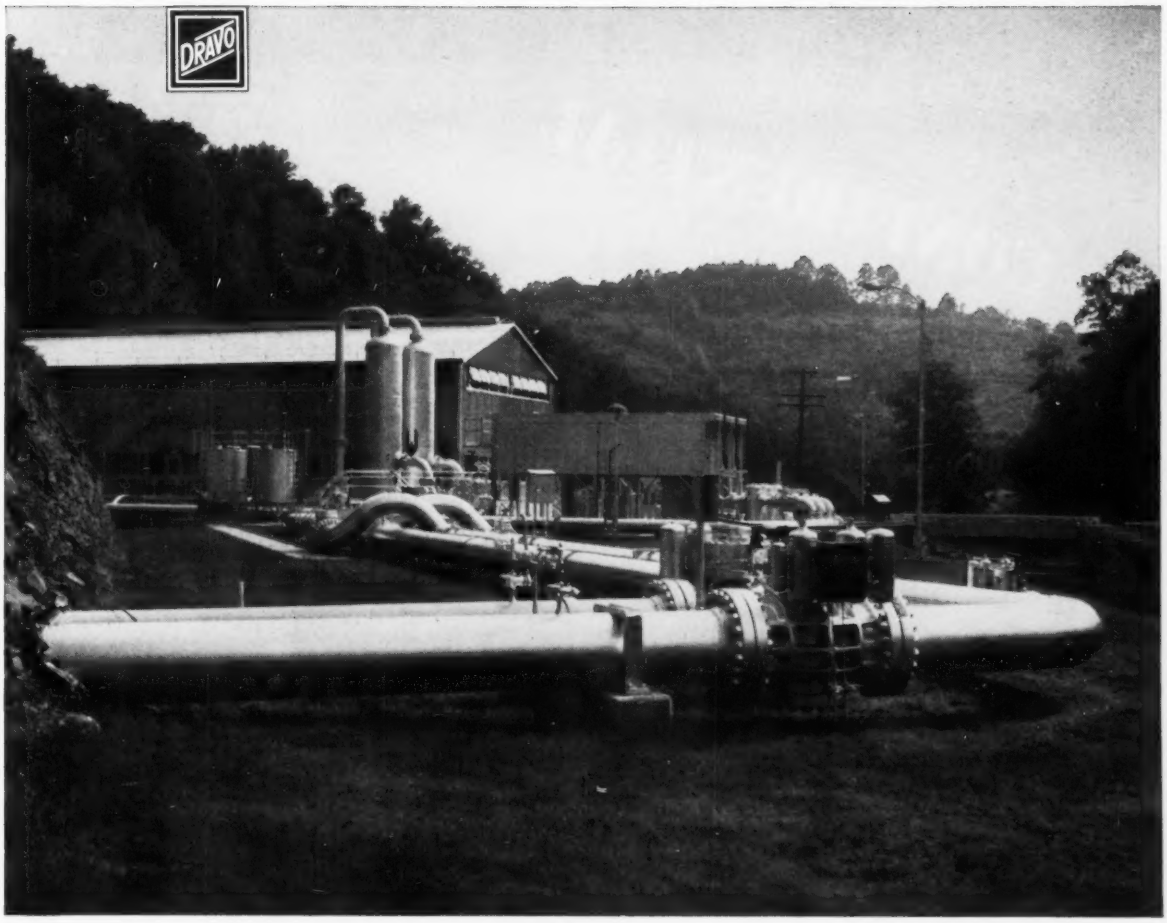
A high-quality gear oil should have good water-separating ability not only when new but throughout its service life. With such an oil, water settles out so it can be drained periodically. However, it is necessary to reduce water contamination and to keep the oil as clean as possible.

Anti-rust ability. The elements that cause rust, air (oxygen) and water, are always present in gear cases. A certain amount of air is normally dissolved in oil so oxygen cannot be excluded. But a suitable gear oil should contain materials capable of forming films on metal surfaces which will minimize contact with water and, therefore, protect oil-wet surfaces against rusting.

This concludes our brief discussion of gears and their lubrication. Next article in this series discusses some of the basic causes of gear-tooth failures.

World's longest conveyor belt to be shipped in one piece recently left Manhattan Rubber Div of Raybestos-Manhattan, Inc. Length is 2940 ft.

Palo Seco plant, San Juan, Puerto Rico, will have initial installation of two turbogenerators rated at 82,500 kw each. Final installation will be 1 million kw supplied by eight units. Plant is first of outdoor type to be built in Latin America.



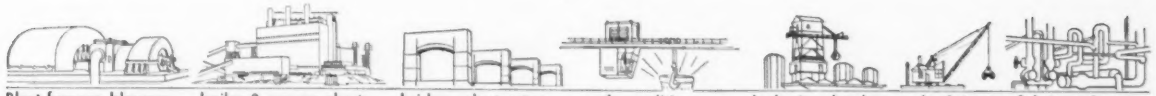
Pipe prefabrication simplifies construction problem

Located at a scenic and rugged mountainous section of West Virginia, the Sweeney Compressor Station presented many construction problems for Hope Natural Gas Company's engineers.

Fabrication of heavy-walled carbon steel pipe at the site proved impractical. Weight of the pipe alone made it too costly and time consuming. However, working to close tolerances, Dravo prefabricated the pipe in its shops at Marietta. Field assembly required a minimum of welds with most sections simply being bolted together.

Prefabrication of piping to rigid specifications is one of the many Dravo services to industry. For information on this or any products listed below, write to DRAVO CORPORATION, PITTSBURGH 25, PA.

DRAVO
CORPORATION



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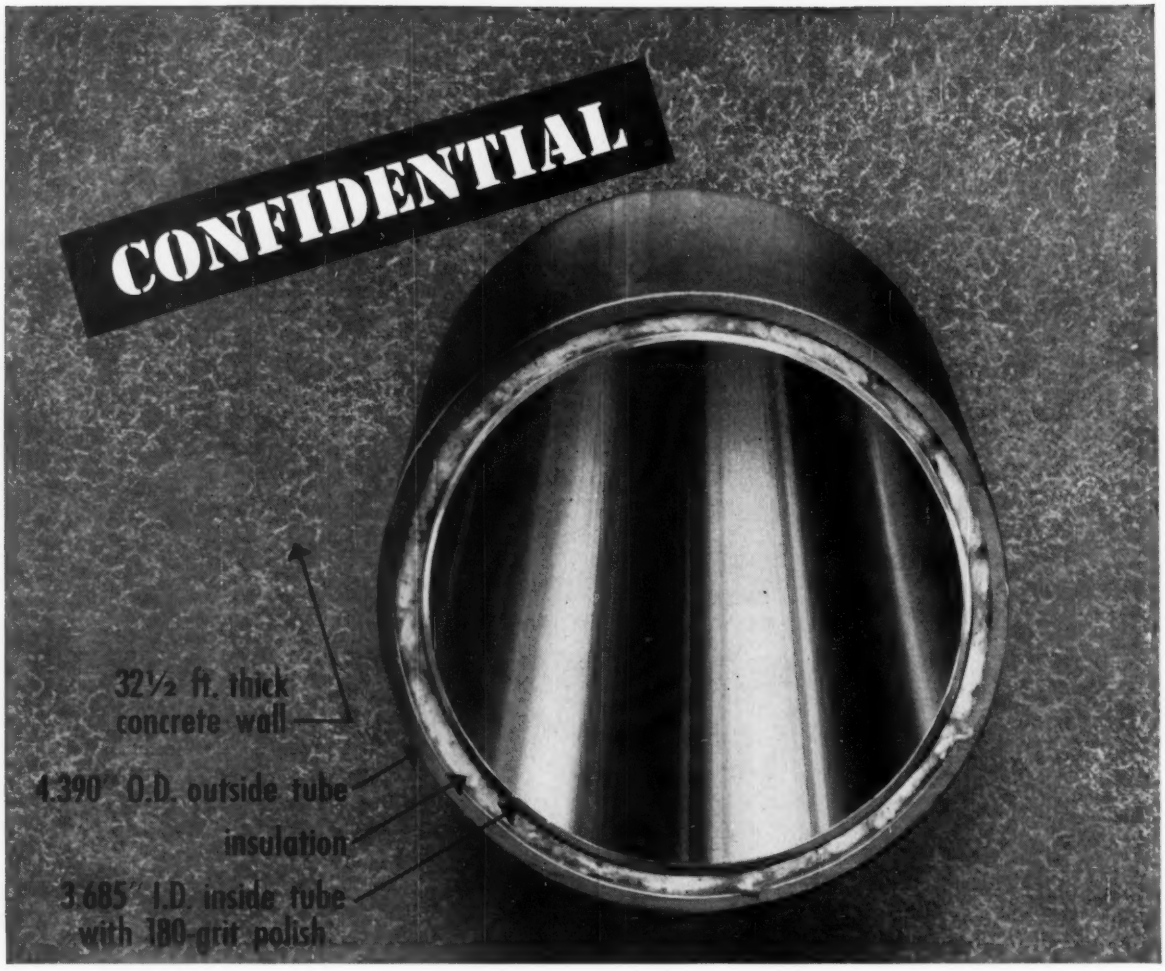

Proof why it pays to design *Carpenter* Welded Stainless Tubing into tough spots with "skin-tight" limits

Unusually close dimensional tolerances were required by the AEC on nearly 500 ft. of Carpenter Stainless Tubing now being used in the development of nuclear power reactors. The tubing of two different diameters is installed as shown by the above illustration through a 32½ ft. thick concrete wall. Temperature inside the tubing during operation ranges between 1600°F and 2000°F.

The outside tubing was produced within these close limits: 4.390" O.D. (+.000/−.025) ×4.100" I.D. (+.040/−.000); the inside tubing tolerances were: 3.830" O.D. (+.000/−.030) × 3.685" I.D. (+.040/−.000).

Let us demonstrate for you this same ability to produce uniform high quality corrosion and heat-resistant tubing to the tightest specifications. Call in your nearby Carpenter Distributor or Representative for a discussion of your needs.

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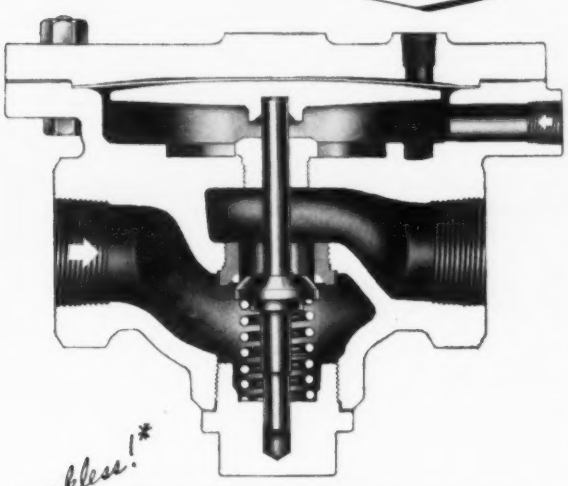
Carpenter

more than corrosion resistance

Stainless Tubing & Pipe

A NEW LESLIE FINAL CONTROL ELEMENT



packless!*

A REALLY VERSATILE CONTROL VALVE — with only two moving parts and a metal diaphragm*

Now, simplified instrumentation combines the simple air loaded, Leslie diaphragm operated valve with various air operated devices. This is the valve that filled a real need when introduced about a year ago, wearing a 3-year guarantee against maintenance in normal pressure reducing services.

This new final control element is gaining wide acceptance for use with a variety of pneumatically operated controllers — simplifying pressure reductions, temperature regulation, remote stop valve applications and many process steam control services.

Ideal for "problem" installations

This control valve is ideal for either continuous or intermittent service and has remarkable immunity to dirty steam. Furnished in cast iron, sizes ½ - 2", it is suitable for any steam service up to 250 psi, 450F, and many fluid services.

It's simple — it's accurate

This Leslie control valve has only two moving parts ... no fussy seals, no stuffing boxes, no small dirt-catching parts; yet, with all its simplicity, it provides uncanny accuracy with its double* feed-back action. It lends itself readily to remote adjustment, too.

More Information

Ask your Leslie engineer to tell you more about this really versatile valve and the simplified instrumentation "packages" now available. You'll find him listed in your classified directory under "Valves" or "Regulators" and eager to come up with new ideas for simplifying pressure, temperature and liquid level control systems.

Send for Bulletin 561-A

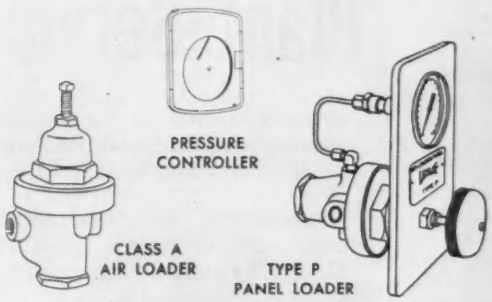
* These are the President's comments — even the ad manager didn't know all the fine features!

TRADE LESLIE MARK **REGULATORS and CONTROLLERS**

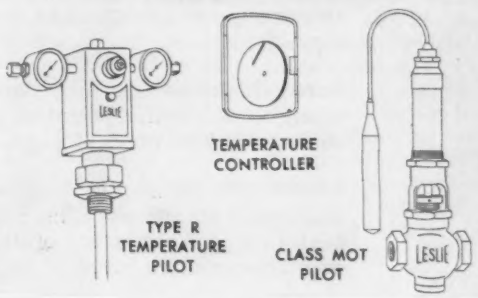
235 Grant Avenue, Lyndhurst, New Jersey

OPERATE THIS CONTROL VALVE
With ANY Of These PNEUMATIC DEVICES

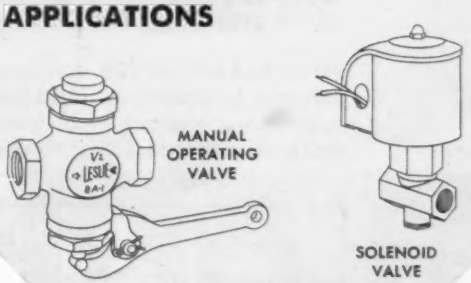
PRESSURE REDUCTIONS



TEMPERATURE REGULATION



REMOTE STOP VALVE APPLICATIONS



POWER'S
Plant Service Reference File

BUILDING HEATING. 20 pages of fundamental data on how to figure heat loads, distributing heat, putting heat to work. Includes typical systems, valves and fittings and section on how heat behaves. Per copy 75¢.

REFRIGERATION. Boiled-down facts on refrigeration systems and their components—compressors, evaporators, condensers, controls, piping, refrigerants. Timely pointers highlighting current practices, helpful tips in applying refrigerants and equipment available. Per copy, 75¢.

FANS. Principles, basic types, centrifugals, propeller, tube-axial and vaneaxial arrangements, fan characteristics, control, applications, maintenance. 16 pages. Per copy 40¢.

PUMPS. Important facts about industrial pumping in easy-to-read form, covering widely used industrial pumps of all classes—the pumps you are most likely to encounter in your work. 32 pages. Per copy, 75¢.

COMPRESSING AIR. 20-page illustrated handbook covers the compressors that take in atmospheric air and give it the pressure boost that makes it useful; the auxiliaries needed for good compressor operation and the distribution system that puts air to work throughout the industrial plant. Per copy, 75¢.

AIR CONDITIONING. What you need to Know About Air Properties—The Necessary Tools—Heating and Cooling—Moisture Control—Air Distribution—Refrigeration —How to Fit Equipment to the Job. Per copy, 75¢.

BEARINGS & LUBRICATION. In 32 pages this report wraps up the practical aspects of industrial lubrication . . . right from the story of friction and how to lick it to the mechanics of planning a lubrication program for your plant. The bearing picture is well covered even including wood, nylon and plastic bearings. Per copy, 75¢.

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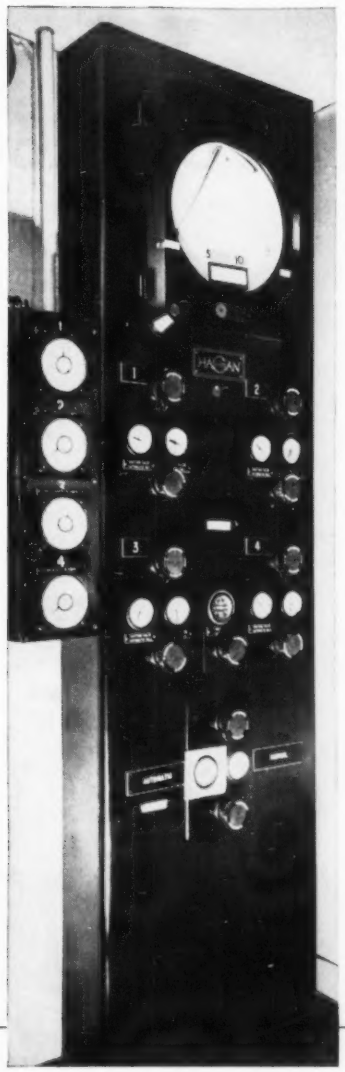


HAGAN CONTROL SPEEDS ANTIBIOTICS PRODUCTION—LOWERS COSTS

Precise compressor controls pay for themselves at Squibb plant

At the New Brunswick plant of E. R. Squibb and Sons, fermentation tanks containing the micro organisms which produce antibiotics depend on a constant supply of air. Any interruption increases the possibility of contamination, lowers production, and may involve complete loss of the batch.

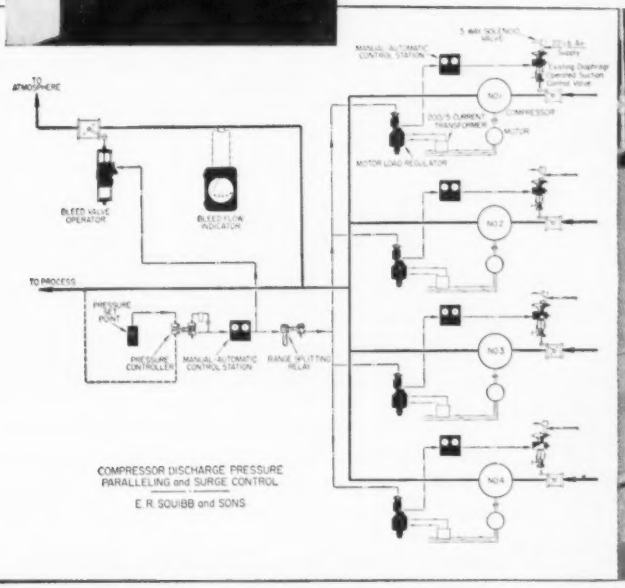
The manual controls on the four 12,000-cfm, 4-stage centrifugal compressors, used prior to the Hagan installation, made use of an elaborate alarm system and resulted in both overloading and surging of the compressors. At changeover, when a fermentation tank was added or removed from the line, excess air would be discharged into empty tanks to keep compressors from surging, and extra personnel were needed to handle valves and motor current controls.

With the installation of the Hagan system, these problems disappeared. Both valves and motor current are now under automatic control, with the result that frequent starting and stopping of compressor motors has been curtailed, all tanks receive the proper air pressures, there is no need for extra operating personnel to handle changeover, and the compressor system as a whole is operating efficiently. The savings in personnel, in lower average power consumption and in higher production has more than paid for the system.

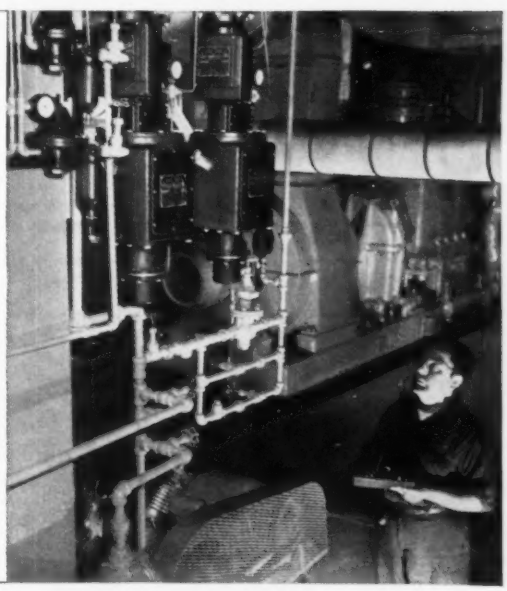
Hagan automatic controls for a great variety of processes are available as complete systems or as integrated components which may be linked together or made a part of existing controls. Hagan has pneumatic, hydraulic or electronic components which can be used in a variety of combinations. A Hagan engineer will be glad to work with you in solving your particular control problem. For more information, write or phone:

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED, TORONTO



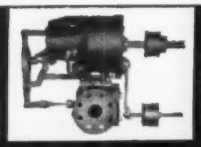
COMPRESSOR DISCHARGE PRESSURE PARALLELING and SURGE CONTROL
E. R. SQUIBB and SONS



The heart of the system is the pressure controller which maintains process air pressure by varying compressor motor load between allowable limits, and by controlling the bleed valve opening when compressor load has been reduced to minimum.

Two of the motor load regulators which receive a signal from the pressure controller. They prevent overloading or unloading (surging). Write for specification sheet GE500, which describes the Hagan Alternating Current Controller's unusual features.

STOP WASTING STEAM



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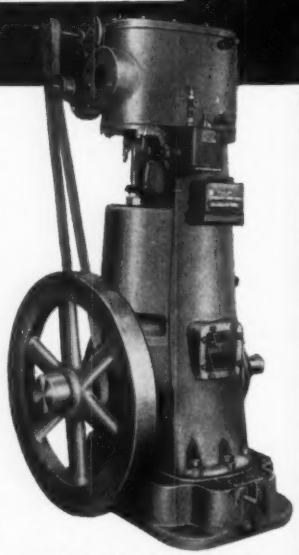
Let Troy Steam Engines and Generators produce dollar-saving "BY-PRODUCT POWER" from steam available for processing or heating. You can use this low-cost power for many operations in your plant, even against high back pressures!

Use it for—

Generating Electrical Power

Mechanically Driving stokers, pumps, fans, compressors and other equipment.

It will pay you to investigate this source of cheaper power. TROY Equipment can be your key to COST REDUCTION! *Send for Booklet #306.*



Type E. Engine, 12.5 to 100 HP.

TROY Engine & Machine Co.
703 Parsons Street Troy, Pennsylvania

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24 pages of helpful, easy-to-use information on choosing Silencers and Spark Arrestors. Discusses design and construction, sizes and types for every industrial, mobile and marine use.

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Equipto modern-flow LOCKERS

1 six times faster set up
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4 pilfer-proof, positive latching mechanism
5 no nuts, no bolts, no tools
6 scientifically designed, attractive louvres
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8 low initial cost
9 new assembly method obsoletes all other locker assemblies

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STEEL SHELVING . . .
PARTS BINS . . .
LOCKERS . . .
DRAWER UNITS . . .
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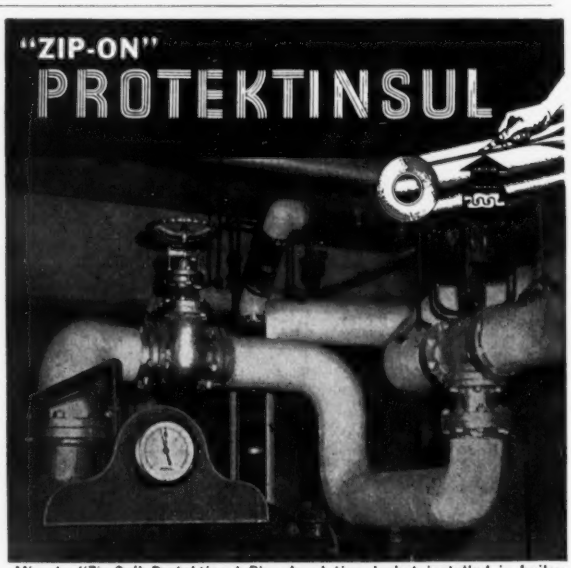
WORK BENCHES

"ZIP-ON"
PROTEKTINSUL



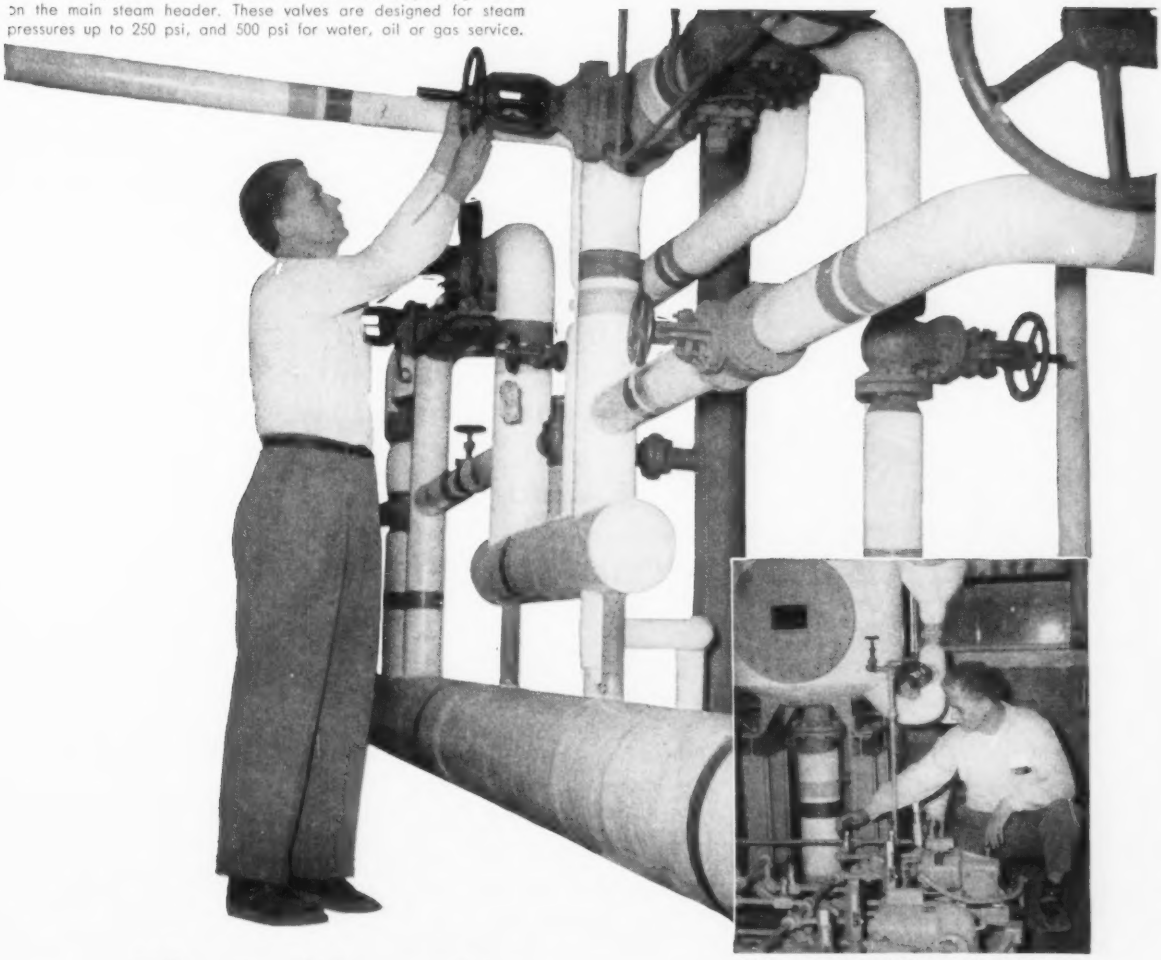
Miracle "Zip-On" Protektinsul Pipe Insulation Jacket installed in boiler room of Esso Bayway Community Center, Elizabeth, N. J.

Easy "Zip-On" installation ■ No maintenance painting ■ Excellent appearance ■ Non-inflammable ■ Chemical and mildew proof ■ Perfect vapor barrier.

FREE: Colorful, illustrated PROTEKTINSUL brochure, no obligation.

MIRACLE ADHESIVES CORPORATION
250 Pettit Avenue Bellmore, L. I., N. Y.

The Chief Engineer closes an 8-inch Walworth Iron Body Wedge Valve on the main steam header. These valves are designed for steam pressures up to 250 psi, and 500 psi for water, oil or gas service.



Chief Engineer Bruce W. Martin checks Walworth Bar Stock Valves in chemical feed pump lines to boiler and feed water. These carbon steel valves are built for ratings up to 3000 psi. Stainless steel bar stock valves are also available for very severe service.

"from big gates to little globes"...

The power plant at the Michigan School for the Deaf has an operating capacity of 25,000 lbs. per hour generated by three 200 hp and one 60 hp oil-fired boilers. Built four years ago, the plant is now the responsibility of Chief Engineer Bruce W. Martin who says: "This plant was designed and constructed for efficient operation, and a lot of that efficiency depends on the valves. From big gates to little globes installed here, we use a wide variety of Walworth Valves. They give us the dependable, trouble-free service we want and expect. I would recommend them to anybody for similar service."

Walworth's complete lines of valves are built to provide long range service and savings. There's a Walworth Valve in a type, size, and material to serve you . . . Gate, Globe, Angle, Check, and Lubricated Plug Valves in a variety of pressure ratings. The next time you need valves or have a problem concerning flow control, call your Walworth Distributor, or, write Walworth direct.

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two

best

friends...

"the man ahead"

and

"the man behind"

That man just ahead of you hopes you'll take his job away from him. He's plain selfish about it . . . that way you push him up the ladder, too.

The fellow right behind you, what about him? He's another good friend. Just help make him more capable of capturing your present spot . . . see, now he's pushing you!

How can you serve yourself better than you ever have before? By upgrading your own job performance. By learning all you can about other functions of your company's business. By putting today's problems together with tomorrow's promises . . . and becoming more and more knowing about both, right here in the high-utility pages of this one specialized publication.

This, don't ever forget, is your own magazine — for you and men like yourself to work things out together — to find new and better ways to make progress and profits. McGraw-Hill editors, who live on your street, unceasingly strive to make it the single greatest community of interest for your industry. And the more effort they put into it, the easier it is for you to get more out of it for every reading minute invested.

Look ahead, read ahead, get ahead. Live this secret. Share it. After you've read this issue so satisfyingly, hand it over to that man one step below. Show him how much there's in it for him, too. A few issues from now, we'll bet he looks you in the eye and says, "Thanks, friend. I just got my own subscription."

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Write stating education, experience, salary expected, and availability. All replies will be held confidential.

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WANTED

Diesel Engine Generator Set, 1000 to 2000 KVA 1/60/13200 volts preferred would consider 2300 volts.
Steam Turbine Generator Set—3/60/ approximately 1,000 KVA, 400 pounds pressure—13200 volts preferred would consider 2300—with or without boiler and coal burning equipment.

SOUL CLINIC INC.
Calgary, Alberta, Canada

WANTED
FREQUENCY CONVERTER

1000 KW, 3 Phase, 60 Cycle, 4160 Volts synchronous motor driver; 25 Cycle, 3 Phase, 480 Volt driven. Multiple units & other voltages considered.

ROGERS-SCHMIDT ENGINEERING CO.
4981 Fyler Ave. St. Louis 9, Mo.

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NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

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Electrical Engineer: Graduate electrical engineer with one to five years of experience for progressive midwestern paper mill. All replies held strictly confidential. P-6903, Power.

Chemical or Mechanical Engineer. Experienced in high pressure steam station operation with emphasis on water conditioning and allied problems. Some traveling assignments, not extensive. Starting salary $10,000 or better, depending on education and experience. Education and experience record to be submitted with application. P-7115, Power.

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Steam Boiler or Generator Distributors with Primary Sales and Service in the medium pressures (30-100 lb.) and Good Experience in steam with clothing, laundry, and dry cleaning industries, wanted to handle sales and service of miniature (¼ H.P. up to 5 H.P.) Electric Steam Generators up to 100 lbs. pressure each unit bearing a Registered National Board of Boiler and P.V.I. Number, individually inspected under the miniature boiler code. Please reply to RW-6528, Power.

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Wish power plant job, anywhere; B.S. degree in Industrial Arts for KSTC, Pittsburg, Kan. Experience in pipefitting, electrical and machine shop work; age 46; ICS student. John Radovic, 313 So. Pine, Hamburg, Ark. Phone ID 3-5328.

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Sales Manager, BSME, age 35, 13 years sales of rotating machinery to steel, chemical, power, petroleum, and automotive industries. PW-6895, Power.

Power Plant Superintendent, age 36, technical education, 12 years experience in the operation, maintenace and plant betterment of turbo-electric power plants. PW-6856, Power.

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Complete power plants, turbo generators, Boilers, Condensers, Engine generators, Processing Plants and equipment.

PAUL OBERMAN
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WANTED BOILER

7500 to 8000 Kgs Steam and Pressure 42 Kg or 600 lbs. square inch.

New or Semi New. Immediate Delivery.

W-6795, POWER
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

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NON-CONDENSING STEAM TURBINES
500-2000 KW
TRANSFORMERS—AIR COMPRESSORS
ELECTRIC MOTORS

PAUL JAY
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DIESEL GENERATOR—FOR SALE

G.M. 8-268A Engine—2000 Amp. 0-180 Volt D.C. Generator—Price $7,500.00 or $5,000.00 for Diesel Engine alone. Will also trade for equal value in Package Boiler—heavy oil, 125 lbs. pressure approx. 200 h.p.—or other chemical equipment.

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28,000 pounds steam per hour Babcock & Wilcox Package Boiler, type FM9, size 61, integral furnace, 175# steam pressure, oil or gas fired, mounted on steel skids, complete with automatic control.

New 1953 — Excellent Condition

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4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired. *Price reasonable.*
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

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55,000#/HR. BOILER—NEW IN 1953
B & W, Design Pressure 650#, Temperature 750° F.
5000—35' FULL TREATED POLES, CLASS 3 & BETTER Used, age 2 to 8 yrs.—Carload lots.
63—TRANSMISSION TOWERS, 80', DOUBLE CKT., 69 KV.
300 KW ELLIOTT TURBO-GENERATOR
425# psig, 3600 RPM, 2400/4160 V, 3-phase, 60 cycle Ex. 5#G, Condenser, etc. Can operate non-condensing.
10,000 KW G.E. TURBO-GENERATOR
175#, 1500 RPM, 2300 V, 3-phase, 25 Cycle. All Aux. New in 1924—Completely overhauled in 1952.
COMPLETE POWER PLANT & AUXILIARIES
2—1500 KW Turbo-generators—1 New 1948, 400# 750° F.
1—1000 KW Turbo-generator.
B & W Boiler, 45000#/HR at 450#—New in 1951
B & W Boiler, 27000#/HR at 450#—New in 1948
All necessary auxiliaries for complete power plant.

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ROYAL GULL AMPHIBIAN

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- Used Exclusively as a Demonstrator and in Excellent Condition throughout; only 300 Hours since Manufacture.
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700 KW Chicago Pneumatic Diesel Engine, 8 cylinder, 4 cycles, 327 rpm. Complete with all auxiliaries. General Electric alternator 3/60/2400/4160/6900 volts. *READY TO SHIP.*

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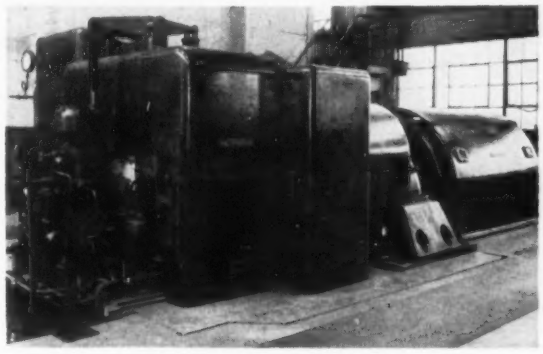

ACTUAL RECENT PHOTOGRAPH

Above exceptionally fine unit placed in service in 1949 and constantly maintained in excellent condition. Turbine designed for 650 P.S.I.G., 725° F.T.T., automatic extraction at 125 P.S.I.G., Westinghouse Generator 9375 KVA, 7500 KW, 6900 volt, 3 phase, 60 cycle, 3600 RPM, with dir. conn. 125 volt exciter. Complete with surface condenser, switchboard, voltage regulator and operating auxiliaries.

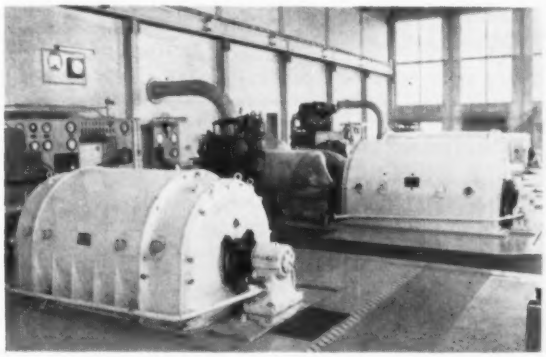

PHOTO OF OTHER AVAILABLE WHSE. TURBO-GENERATORS

These additional units in other power plant — same location — here locally where recently discontinued from service. All designed for 650 P.S.I.G., 725° F.T.T., Westinghouse Generators 6600/6900 volt, 3 phase, 60 cycle, 3600 RPM.

1—9375 KVA, 7500 KW, 125 P.S.I.G. auto extraction, surface condenser, installed in 1937.

1—9375 KVA, 7500 KW, non-condensing, 125# B.P., installed 1930.

1—6250 KVA, 5000 KW, Condensing, with surface condenser, installed 1942.

1—5000 KVA, 4000 KW, non-condensing, 125# B.P., installed 1927.

1—5000 KVA, 4000 KW, 380 P.S.I.G., non-condensing, 125# B.P., installed 1930.

All units complete with operating auxiliaries.

Can be inspected where installed — Bargain Prices.

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SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
2500	*G.E.	MT (Mill Type)	257
1100	*G.E.	MT	720
1000	*G.E.	M-575-S	1200
1000	*West.	CW	450
600	*G.E.	M-6345-S	1800
500	G.E.	M-6345	1200
400	*G.E.	MTP-565	1200
350	*Al-Ch	ARYW	1800
300	Cr-Wh	SR-70-R	1800
250	Al-Ch	ARY-626	1800
250	*G.E.	I-M-17A	720
200	G.E.	I-M-16	600
200	*West.	CW1950A	514
150	Cr-Wh	SR-50R	1800
150	G.E.	I-M-15A	600
125	G.E.	I-M-15A	600
100	G.E.	I-E-13A	1800
100	G.E.	MT-558	720
100	G.E.	I-M-15A	425
75	West.	CW-770	1200
75	G.E.	MT-347	1200
75	G.E.	MT-356	900
75	G.E.	MT-352	720
75	G.E.	I-M-10	600
60	G.E.	MT-536	1200
60	*West.	CW-762C	900
50	*G.E.	MT-536	1200
50	Al-Ch	ARY-223	900
50	West.	CW-758	720
50	Al-Ch	ANY-26	600
40	G.E.	MT-532	1200
40	G.E.	MT-336	900

HUNDREDS OF SLIP RINGS OF SMALL SIZES — ALL SPEEDS

SLIP RING MOTORS

Crane & Hoist Service
3 phase, 60 cycle, 220 or 440 volts

H.P.	MAKE	TYPE	SPEED
100	G.E.	MTC-5546	900
80	G.E.	MTC-5552	600
75	West.	CI-756A	600
50	G.E.	HK	600
35	G.E.	MTC-5536	600
25	West.	CI-636A	720

M.G. SETS

K.W.	MAKE	A.C.	D.C.
1200	Al-Ch	4160	600
1000	West.	4160	250
500	West.	440	220/110
400	Al-Ch	2300	240/120
300	West.	2300	250
250	G.E.	440	250
200	West.	2300/4000	250
200	G.E.	2300	250/275
200	Rdgwy	2300	250
150	Al-Ch	2300	250/275
150	G.E.	440	257/275
150	West.	2300/440	250/125
125	G.E.	5000	250
125	West.	2300	250
125	C.W.	4160	125
100	G.E.	2300	250
100	G.E.	2300/4000	250/275
100	West.	2300/4000	250/275
100	E.M.	220/440	125
90	G.E.	220/440	125
60	G.E.	220/440	250
50	Reliance	220/440	250

CHICAGO Electric carries a complete stock of REBUILT power equipment:

AC & DC MOTORS
GENERATORS
M. G. SETS
FREQUENCY CHANGERS
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WELDERS
ENGINE GENERATORS
STEAM-TURBO
DIESEL-GAS
TRANSFORMERS
CONTROLS

SQUIRREL CAGE MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

H.P.	MAKE	TYPE	SPEED
1750	*G.E.	K	3600
1750	*G.E.	K	1800
1250	*Al-Ch	ANX	3600
600	West.	CS	720
600	*G.E.	K-63455	1200
500	*G.E.	K-63455	1200
500	*G.E.	I-13-E	900
350	*G.E.	KT-559-A	1800
300	*G.E.	K-6344	1200
250	*W (TE)	CS-81205	1800
250	*G.E.	KT-599-S	1800
250	*West.	CS-875-S	1800
250	Brook	RS-28	1200
200	*G.E.	FT-540	3600
200	*G.E.	I-K-13B	1800
200	West.	CSP-581-S	1800
200	Brook	RS-27	1200
200	*West.	CS-930-A	900
200	G.E.	KT-564-S	720
200	*Al-Ch	AN-37-G	720
200	*West.	CS-1010	600
200	Al-Ch	ARW-631	600
150	Cr-Wh	SC-140	3600
150	Al-Ch	AN-30-F	1200
150	West.	CSP-5815	1200
150	G.E.	I-K-15A	900
150	*West.	CS	600
125	Al-Ch	AR-226	1800
125	Cr-Wh	5-Q	1200
125	G.E.	K-558	900
100	W (TE)	CS-507-S	3600
100	G.E.	FT-542-Z	1800
100	Al-Ch (TE)	ARZ-826	1200
100	Al-Ch	AW-23-D	1200
100	G.E.	KT-556	900
75	Al-Ch	AR-445	3600

SPECIAL NEW WESTINGHOUSE

Single Step, Primary resistance magnetic Squirrel Cage Motor Starters, 3/60/—Class 11-400 Size 5

QUA.	HP	PRICE
10	100	$1075.00
8	200	1175.00

SAVE 40%

WRITE FOR CURRENT STOCK LIST

CHICAGO *Electric* Co.

ALL TYPES OF EQUIPMENT IN STOCK

1320 W. CERMAK RD. • CHICAGO 8, ILL. • PHONE: CANAL 6-2900

BARGAINS NEW CONDENSER

11000 SQ. FT. UNITS

3 New Worthington Surface Condensers—11000 sq. ft. each—single pass—Monel water boxes—Cupro-Nickel tubes & tube sheets. Tubes ⅝" O.D. CAPACITY: lbs/hr—70,000; circulating water 14180; circulating water connections 30"; operating weight 86,000 lbs; overall length approx. 21'; width & height 9'4". Built

8900 SQ. FT. UNITS

for U.S. Navy. Designed for low head room. 1 New unit by C. H. Wheeler. Test pressure: shell 30 lbs; water box 30 lbs.—single pass. Turbine steam exhaust inlet 6' 13¾" x 10' 2". Overall width 12' 2¼"; overall length 14' 10³¼"; overall height 5'7". Water inlet 36" x 30" outlet. Monel heads and water boxes; Cupro-Nickel tubes. Built for U.S. Navy of very best materials.

1135 SQ. FT. UNITS

2 New Units by C. H. Wheeler. 2-pass—shell 30 PSI—tubes, chest 30 PSI: DIMENSIONS: 42" diam.—12' long. 24" exhaust steam inlet —water box inlet & outlet 10". 9300 lbs./hr. steam capacity; 1175 GPM circulating water. Complete with twin air ejectors type 4H Wheeler with inner cooler. Built originally for Navy.

580 SQ. FT. UNITS

6 New units—Capacity: 4300 lbs/hr on 28.5 vacuum. 8" water inlet & outlet—18" steam inlet. 2 pass— complete with air ejectors.

3 LIBERTY SHIP TYPE UNITS

2700 Sq. Ft.—2-pass type.

OTHER SIZES IN STOCK FOR IMMEDIATE DELIVERY

NEW CIRCULATING PUMPS

1 only—vertical circulating pump—all-bronze propeller type—geared turbo driven—840 RPM —26500 GPM at 25' head. W.P. turbine, Westinghouse, 575 lbs—0°F superheat. Pump—Warren type 25 VP.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

G.E. STEAM TURBINE GENERATORS OFFERED AT A SMALL FRACTION OF REPLACEMENT COST

(Not an actual photo but similar)

375 lb. throttle pressure, single & double automatic extraction—non-condensing 3 phase 60 cycle 480 volts.

1—1500 KW extraction, 150 lbs. exhaust 85.
1—2000 KW extraction, 150 & 85 lbs. exhaust 10 lbs.
1—2500 KW extraction, 150 & 85 lbs. exhaust 10 lbs.

All complete with breakers, voltage regulators and miscell. accessories. Ideal for Paper, Sugar & Chemical Industries. Mfd. in 1933.

JOLIET EQUIPMENT CORP., Box 1078, Joliet, Ill.

FOR SALE

2812 KVA DIESEL GENERATOR UNIT

2812 KVA Crocker Wheeler generator, 3 phase, 60 cycle, 12,000/6900/4160/2400 volts direct connected to 3000 HP Busch-Sulzer (Nordberg) diesel engine, 10 cylinders, 240 RPM, complete with auxiliaries as in operation.

Used only 5 years—Excellent condition

INTERNATIONAL POWER MACHINERY COMPANY
1610 Union Commerce Building
Cleveland 14, Ohio Main 1-9514

FOR SALE — EXCEPTIONAL BARGAINS

Diesel Generator Units, 200 KW-1500 KW — Turbo Generators, 500 KW-10,000 KW
Motor Generator Sets—Rotary Converters—Synchronous Condensers—
Frequency Changers—Transformers—Pumps, Boilers.

UTILITIES MACHINERY CORPORATION
1965 East Sixth St., Cleveland 14, Ohio • PHONES: CHerry 1-0210 & CH 1-4070

COMPLETE DIESEL PLANT

2—Fairbanks Morse 450 HP Model 32E14 375 KVA. 3/60/2400 volts. With complete auxiliaries. New in 1944.

1—Fairbanks Morse 360 HP Style VA, 257 RPM 300 KVA. 3/60/2400 volts. With auxiliaries.

These units can be purchased individually at a real bargain price. Condition is first-class.

WHISLER EQUIPMENT CO.
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DIESEL SALES & SERVICE
Complete Switchboard Design & Construction
GENERATORS—GAS OR DIESEL
USED & REBUILT EQUIPMENT
UNIVERSAL POWER ENGINEERING CO.
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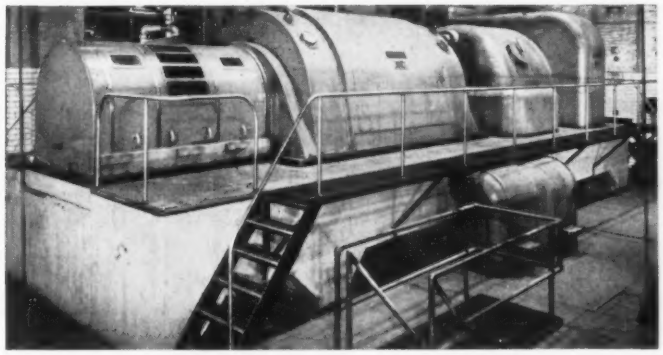
Phone: DElaware 2-8300

300 & 426 HP B&W Water Tube Boilers
50 & 260 HP Kewanee Firebox Boilers
25 to 100 HP Slow Speed Slip Rg. Mtrs.
250 KVA Skinner Unaflow Eng. Gen. Set
25 & 150 KVA Diesel Electric Sets
6 to 12" Capacity B&K Pipe Threader
150 HP, 150 lb. P. Firebox Boiler
260 HP, 150 lb. P. HRT Boiler
H. & P., 6719 Etzel, St. Louis 14, Mo.

IMMEDIATELY AVAILABLE

650 LB. PRESSURE, 750° FTT TURBINE-GENERATORS

10,000 KW, 70% P.F., 14,286 KVA below:



This 10,000 KW is a Westinghouse, Condensing 650 Lb. PSIG, 750° FTT Turbine. It is equipped with Surface Condenser, Switchboard, with all auxiliaries, direct connected Exciter (closed type). Generator is 3/60/12000 V., 3600 RPM at 70% P.F., 14,286 KVA. Installed new in 1947.

CHARLES WEAVER, INC.

19701 James Couzens Hwy. **Tel: BRoadway 3-1900** **Detroit 35, Michigan**

TRANSFORMERS

3—833 KVA, 1/60/34500-460 Moloney OISC with taps
2—250 KVA, 1/60/2400-240/480 Moloney OISC, type YC, with taps
1—300 KVA, 3/60/4160-240 Wagner, ITE type HPE Unit Substation, Outdoor.
1—200 KVA 3/60/4160-240 Wagner, ITE type RPB Unit Substation, Outdoor.
1—225 KVA 3/60/440-208Y/120, Moloney Dry type.
4—15 KVA, 1/60/240-480/120-240 Moloney Dry type

CASH

For Surplus Electrical Equipment

BENSON-WILIMZIG, INC.

1708 North 8th St., St. Louis 6, Mo.
Phone GArfield 1-4290

POWER PLANT EQUIPMENT

SPECIAL OFFERINGS

TURBO-GENERATORS

1—3000 KW — 13,200 V — N. C. 425# — 170 Ext.—50# BP
1—3000 KW—4150 V 350# Cond.
2—2000 KW—6600 V—N. C. 625#—155# BP
1—1000 KW—240/480 V—Cond. 130/250#—Ext. #15
2—750 KW—250 V—DC—N. C. 250#—25# BP
1—300 KW—480 V—Cond. 210#—Ext. 40#
1—250 KW—240/480 V — N. C. 130# — 10/15# BP

DIESEL LOCO. CRANE

1—25 Ton—50 Ft. Boom.

A. LEE ELLIS CO., U.S. Machy. Bldg., 140 Federal St., Boston 10, Mass.

THE BUYERS MUST BE SATISFIED—ALWAYS

HIGH PRESSURE STEAM BOILERS

Government Surplus SAVE OVER 75%

NEW, NEVER USED, NEVER ERECTED, AVAILABLE IMMEDIATELY

121,650 Lbs.

1 Foster Wheeler
Express Type, 3-drum, with integral superheater separately fired.
Includes boiler, superheater, economizer, 7 fuel oil burners, soot blowers.
Pressure 634 psi, temp 850° F.
Furnace Vol: boiler 310 cu. ft., superh. 247 cu. ft.

60,000 Lbs.

10 Babcock Wilcox
3 Foster Wheeler
"D" Type, 2-drum, with integral superheater fired between boiler tube bank.
Includes boiler, superheater, economizer, 3 fuel oil burners, soot blowers.
Pressure 435 psi, temp 750°F.
Furnace Vol: 330 Cu. Ft.

55,000 Lbs.

1 Wickes Boiler
"A" Type, 3 drum.
Includes boiler, 3 oil burners, soot blowers.
Pressure 250 psi.
Furnace Vol: 420 Cu. Ft.

We own and stock these boilers. Inspection Invited at Utica, N.Y. Subject to prior sales.

PELNIK-LOCONTI INDUSTRIAL SUPPLY CO.

Office Ph. Utica 6-4621 • 315 Oriskany St., Yorkville, N.Y. • Yard Ph. Utica 2-4513

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Maloney	TCR	3	7200/6600-4160/2400
2	750	G.E.	K	1	4600-120/240
1	750	G.E.	HT	3	4150Y-208/416
3	500	West.	SL		4800/2400-240/480
1	300	Penna.	(Askarel)	3	12470Y/7200-240
2	250	G.E.	H Pyranol	1	2400-4800-8320Y 120/240
2	250	West.		1	2300/4600-230/460
3	200	G.E.	H	1	7800-15600-220/440
1	150	Elsler	OA	1	4160-240/480
3	100	G.E.	H. Form W28		2400/4160-240/480
5	50	G.E.	KS	1	2400/4610-240/480
4	25	West.	Hypersil	1	2400/4160-120/240
3	15	West.	H Pyranol	1	6900/11950Y-120/240
1	50	Amer.	Abestol	3	4160-120/208Y

SYNCHRONOUS MOTORS

Qu	HP	Make	Speed	Type	Volts
1	100	G.E.	900	TS	2300
1	125	G.E.	600	TS	2300
1	125	F.M.	900		4800
1	150	G.E.	1800	TS	220/440
2	150	Allis-Ch.	360		2200
1	150	West.	900		220
1	300	Elec. Mch	720	TEFC	2300
1	500	West.	450	HR	440
1	1000	West.	360	Mill	2300/4150

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
2	40	West.	690	CW	220/440
1	60	G.E.	1800	MT	220
1	75	G.E.	600	IM	440
1	100	West.	1800	T.E.F.C.	220
1	150	G.E.	1175	M Triclad, BB	220/440
3	150	Allis-Ch.	1800	AY-RW	2300
1	200	West.	514	CW	440
1	250	West.	600	CW	440
1	350	West.	1800	CW	2300
1	500	G.E.	450	MT	2200

SQUIRREL CAGE

Qu	HP	Make	Speed	Type	Volts
1	25	G.E.	1170	405TEFC	220/440
1	50	G.E.	1200	Tri Clad	220/440
2	75	West.	1180	CS-607	440
1	100	G.E. 543	1775	KTP	220/440
1	150	G.E.	720	KT-562	440
2	200	Cont.	1800	Exp. Proof	220/440
2	250	G.E.	1790	K.T.E.F.C.	2300
1	275	G.E.	1200	KT559BS	2200
1	300	G.E.	1800	K-4150V	new
1	400	Cont.	1200	N806S	2300

MOTOR GENERATOR SETS

Qu	K.W.	Make	Speed	D.C.	AC
3	60	E.M.	1200	125	220 v. Syn.
2	100	West.	1200	250	2300/4150Y Syn.
1	300	GE MPC	1200	250	440/Syn.
1	350	GE MPC	1200	250	440/Syn.
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y S.R.
1	1000	West.	720	600	2300/4160Y

D.C. 230 VOLT MOTORS

Qu	HP	Make	Speed	Type
2	50	Cr. Wh.	700	CM-50H, 230V
1	75	C.W.	900	WP T.E.F.C.
1	150	C.W.	900	WP T.E.F.C.
1	250	Allis Ch.	1750	FBL 149BB

A.C. HOIST MOTORS

Qu	HP	Make	Type	Speed	Volts
1	35	G.E.	MTC	565	440
2	300	G.E.	ITC-5017	600	440

"FOR POWER"
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-3227
PHONE NEW JERSEY—UNION 3-2600

BOILERS

BOUGHT • SOLD • RENTED

1—202 H.P. 150 lb. Keeler Scotch
1—165 H.P. 15 lb. Titusville Scotch
1—200 H.P. 250 lb. Walsh-Widner
1—200 H.P. 15 lb. Cyclotherm #6 Oil
1—300 H.P. 15 lb. Superior #6 Oil
1—200 H.P. 125 lb. Cyclotherm #6 Oil
1—125 H.P. 150 lb. Cyclotherm #6 Oil
6— 90 H.P. 125 lb. Cyclotherm #2 Oil
1— 80 H.P. 250 lb. Cyclotherm #5 Oil
1— 50 H.P. 125 lb. CI Brooks #2 Oil
1— 50 H.P. 125 lb. CI Brooks Gas & Oil
1— 50 H.P. 125 lb. Cyclotherm #2 Oil
1— 60 H.P. 15 lb. Cyclotherm #5 Oil
1— 30 H.P. 200 lb. Cyclotherm #2 Oil

BOILER & EQUIPMENT CO.
743 Bedford Ave., Bklyn. 5, N. Y.
UL. 5-3588

TWO PASS CONDENSERS ALL NEW

400 sq ft Allis-Chalmers, admiralty brass tubes
436 sq ft C. H. Wheeler, cupro-nickel tubes
580 sq ft Foster Wheeler, cupro-nickel tubes
725 sq ft C. H. Wheeler, cupro-nickel tubes
1050 sq ft N.Y. Shipbldg., cupro-nickel tubes
1350 sq ft Alco, cupro-nickel tubes
2000 sq ft Newport News Ship., cupro-nickel tubes
2200 sq ft Alco, cupro-nickel tubes

Larger Sizes Also Available

HUGO NEU CORPORATION
45 Nassau Street • New York 5, N.Y.

500 KW PANEL BOARD

GENERATION CONTROL—UNUSED
220 VOLT A.C. OPERATION

Meters — circuit breaker — transfer switches — rheostat — disconnect switch — voltage regulator — reverse current relay. Free standing dead front modern type. Necessary components for parallel operations.

THE BOSTON METALS CO.
313 E. BALTIMORE STREET
BALTIMORE 2, MD. CUrtis 7-5050

FOR SALE

MODERN POWER PLANT

1875 KVA WORTHINGTON MOORE TURBINE 400 PSI, 700°F Condensing, driving 2300 Volt CROCKER WHEELER GENERATOR 25000#/Hr 450 PSI, 738°F, Coal Fired BOILER; includes all auxiliaries, controls, 25 Ton powerhouse crane and coil handling facilities.

(Will sell boiler or generator set separately)

BOILERS

400 HP B.&W. (Stirling) 160 PSI Oil/Gas fired, ASME, New 1947. (2)
Comb. Engrs. M-2 Package 175 HP—275 PSI oil fired (3)

PARTIAL LISTING ONLY
SEND US YOUR INQUIRIES

GENERATOR SETS

500 KVA RATHBUN JONES Gas Engine Set 3/60/2300V
540 KW WESTINGHOUSE—DC—120/240 Volts Steam Turbine 200 PSI
125 KW WORTHINGTON Gas Engine driven G.E. Alternator, 2300 V, 514 RPM with Panel

TRANSFORMERS

2000 KVA 13,200/120 V FURNACE (3)
750 KVA 12000/45-60 1 ph. 25 cy. (1)
250 KVA 2400/480 1 ph. 60 cy. (3)
75 KVA 4600/115-230 1 ph. 60 cy. (3)

HEAT & POWER Co., Inc.
POWER EQUIPMENT DIVISION
40 EAST 42nd ST. NEW YORK 17, N.Y. MUrray Hill 7-5280
310 THOMPSON BLDG. TULSA 3, OKLAHOMA Diamond 3-4890

4—1000 HP B&W Sect. Header. 4 Long Drum. 1923. 260# WP Superheater. W. Va.

6—800 HP B&W Sect. Header. Cross Drum. 1923-1925. 200# WP. No Superheat. N. J.

1—600 HP B&W Sect. Header. 3 Long Drum. 1922. 225# WP. Colorado.

1—250 HP Keeler "CP". 1950. 160# WP. Automatic Controls. Pa. Ship in one piece.

1—500 HP Cleaver-Brooks. 1946. Full Auto #6 Oil. N. J.

1—300 HP Cleaver-Brooks. 1954. Full Auto #6 Oil. N. J.

3—599 HP Springfield Sect. Hdr. Cross Drum. 1926. 250# WP Superheater. N. Y.

1—60,000#/hr. B&W FF. 1947. 250# WP. Complete pumps, fans, oil burner, oil burner pump set and control panel.

2—2500 KW Westinghouse. Non-cond. Turbines. 135# Initial 5# BP 175# Initial 10# BP 3/60/2300.

1—Permutit Water Softener. 100 GPM Capacity. Zeolarb.

1—Coffin Turbine Driven Feed Pump. 200 GPM. 650 lbs. Discharge Pressure Type "G" Pump. 225# Initial Pressure 10# B. Press.

3—Turbine Driven I.D. Fans. Cleveland Reduction Gears. Size 400. ATW Ratio 7-1. Lee Turbine 40HP @3465 RPM. Fan Capacity 47,000 CFM. Will sell Reduction Gear independently.

1—Turbine Driven DC Generator. 50 KW. 120 Volts. Steam Pressure 150 to 175 lbs. Was used as Turbo Exciter.

1—100,000#/hr. Cochrane Deaerator & Controls. 6 Ft. x 10 Ft. N. Y.

1—30,000 Swarthout Deaerator with Controls & 5000 gal. Storage Tank. Fla.

1—Forced Draft Fan. Dual Turbine & Motor Drive. 15,000 CFM. Fla.

2—Induced Draft Fans. Dual Turbine & Motor Drive. 20,000 CFM. Fla.

1—100 HP Dutton Package Boiler. 1947. 125# WP. Automatic. #6 Oil. N. Y.

1—85 HP 800 p.s.i. B&W Sectional Header. Built 1930. N. Y.

1—60 HP Dutton Package Boiler. 1947. 125# WP. Automatic. N. Y.

SHERB PLANT CONSTRUCTORS
342 Madison Ave., New York 17, N. Y.
Telephone: MUrray Hill 2-9098

BOILERS

HI-PRESSURE
Complete stock from 10-2,000 h.p.
Nation's largest inventory, New & Used
WABASH POWER EQUIPMENT CO.
9750 Skokie Blvd., Chicago (Skokie) Ill. OR 3-8118

FOR SALE

2 B&W #144 COAL PULVERIZERS—Like New Ball Mills (vertical type) Driven By 100 HP, 2300V Motors.

CHARLES WEAVER, INC.
19701 James Couzens Hwy.
Detroit 35, Mich.
Phone: BRoadway 3-1900

FOR SALE

STEAM BOILERS

2—18000 lbs./Hr. Heine 175 psi, straight tube, oil fired, 1920

3—21000 lbs./Hr. Combustion Engr. 200 psi, Stoker fired, 1938

1—28000 lbs./Hr. B&W Package Type, Oil-Gas fired, 1953

1—35000 lbs./Hr. Combustion Engr. 450 psi, 825° stoker fired, 1950

SURFACE CONDENSER

1—2500 Sq. Ft Westinghouse, 2 Pass, with aux., 1950

DIRECT CURRENT GENERATORS

1—100 KW, General Electric, 250V, 1200 RPM, 1950

1—250 KW, Westinghouse, 250V, 720 RPM, 1950

1—250 KW, Allis Chalmers, 250V, 1200 RPM, 1935

MOTOR GENERATOR SET

1—25 KW, Westinghouse, 250V DC, 208/120V AC, 1800 RPM, 1950

DIRECT CURRENT TURBINE GENERATORS

1—100 KW Westinghouse Non-Condensing, 250V DC, 400 lbs., 1950

1—250 KW Allis Chalmers-Murray, Cond., 250V DC, 165 lbs., 1935

WATER PUMPS

1—14000 GPM @, 370' Hd. De Laval Centrifugal, 690 RPM, 1800 HP, 1920

1—20800 GPM, @, 370' Hd. De Laval Centrifugal, 720 RPM, 2500 HP, 1949

1—24500 GPM @, 370' Hd. Worthington Centrifugal, 950 RPM, 3200 HP, 1954

STEAM TURBINES

1—1800 HP, De Laval Condensing, 165 lbs. psi 3600/690 RPM, 1920

1—2500 HP, De Laval Condensing, 400 lbs. psi 3600/720 RPM, 1949

1—3200 HP, Worthington Condensing, 175 lbs. psi 3600/950 RPM, 1954

INTERNATIONAL POWER MACHINERY CO.
1612 Union Commerce Bldg.
Cleveland 14, Ohio **Main 1-9514**

DEAERATING HEATERS — NEW

8—deaerating heaters, 12 spray nozzles, monel shell, capacity 246,500 lbs per hour, mfd. by Elliott Co.

ALSO:
FEED WATER HEATERS, NEW
WATER TO WATER COOLERS, NEW
LUBOIL COOLERS, NEW

HUGO NEU CORPORATION
45 Nassau Street • New York 5, N.Y.

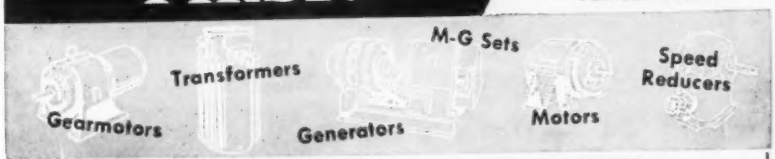
FOR SALE

(1) Keeler 100 C.P. Boiler, 125 lbs, assembled on skids, complete with blow down, safety, non return, header, and water feed valves. Supplied with combustion air fan, gauges & columns.

TRUBEK LABORATORIES, INC.
East Rutherford, New Jersey

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P. OUR 52nd YEAR



A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
500	Whse.	Slipring	2200	450
450	El. Machy.	Synch.	2300/440	400
400	Whse. (2)	Synch.	2200	1800
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2200	3600
400	Whse.	Sq. Cage	2300	900
400	G.E. (2)	Slipring	440	900
400	G.E.	Slipring	2300	514
350	G.E.	Sq. Cage	2200	1800
350	Cont. b.b.	Slipring	2300	900
350	G.E.	Slipring	440	1200
350	Allis Ch.	Slipring	2200/4000	600
300	G.E.	Slipring	2200/440	600
300	G.E. (2)	Synch.	2200/440	360
300	Whse.	Sq. Cage	2200/440	720
300	Whse.	Synch.	440	1200
250	L.A. TEFC	Sq. Cage	2300	900
250	G.E.	Sq. Cage	2200/440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E.	Slipring	220/440	720
250	Whse.	Slipring	440	1200
250	G.E.	Sq. Cage	2200	1800
225	G.E.	Synch.	220/440	900
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	440	450
200	Allis Ch.	Slipring	2200/440	720
200	Whse.	Sq. Cage	2200/440	900
200	G.E.	Sq. Cage	440	600
175	G.E. (2)	Synch.	220/440	720
150	Rel. TEFC	Sq. Cage	220/440	900
150	G.E. (4)	Slipring	2200/440	600
150	Cr. Wheeler	Sq. Cage	220/440	450
150	G.E.	Slipring	220/440	450
150	G.E. (2)	Sq. Cage	2200/440	1800
150	L. Allis b.b.	Sq. Cage	440	3600
125	G.E. TEFC	Sq. Cage	2200	3600
125	Ideal	Slipring	4000/2200	900
125	Allis Ch.	Sq. Cage	2200	900
100	Smith b.b. (6)	Sq. Cage	220/440	1800

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
200	G.E.	RC	600	1150
150	Whse.	SK-184	250	1150
150	Cr. Wh.	CXD	250	650
125	Gen. Elec.	CD	250	1150
100	Allis Ch.	E	125	1200
100	Reliance	651-T	600	1200
75	Gen. Elec.	CD-123	125/250	1200
60	Allis Ch. (3)	E-146	250	1500
60	Ideal	D	125	1150
50	Star b.b.	SQ	250	900
25	Whse.	SK-103	250	1750
20	Ideal	D-405	125	1150

D. C. MOTORS

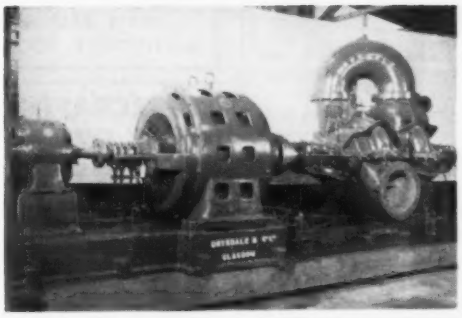
HP	Mfr.	Type	Volts	Speed
200	G.E. b.b.	CY-200	230	1750
170	Cr. Wh.	151-H	230	500
150	Whse.	SK-184	230	850
150	G.E. dynamom.	TLC-50	250	1950/5000
100	Reliance	651-T	550	1000/1600
100	Elliott b.b. T.E.	JH-FE	230	1150
75	Reliance (3)	985-T	230	450/1200
60	G.E. TEFC b.b.	CD-135	230	1150
50	Century	DN-514	230	1150/1750
50	Gen. Elec.	CD-95	230	1800
50	Star b.b.	SQ-92	230	680
50	G.E.	CD-125	230	400/1200
50	G.E.	RF-16	230	250/1000
40	G.E. (2)	CD-93	230	1750
30	G.E.	CD-113	230	500/1500

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	2200 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	G.E.	2200/440 AC	600 DC
175	Gen. Elec.	220/440 AC	250 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
100	Gen. Elec.*(2)	220/440 AC	250 DC
75	Gen. Elec.	220/440 AC	250 DC
75	G.E.	220/440 AC	125 DC
60	Allis Ch.	220/440 AC	250 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Cr. Wh. b.b. (2)	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	250 DC

Arthur Wagner Co.
Certified
MO nroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

2 DRYSDALE ELECT. DRIVEN 2 STAGE H/L CENTRIF. PUMPS 20" SUCTION 18" DISCHARGE



Each unit:—10,000 gallons per minute 271 ft. Head, externally controlled cutwater mechanism, Wellman Bibby Flexible Coupling. 850 BHP, 2200 volt, 3 phase, 60 cycle, 900 RPM motor, all on heavy base. These are modern units completely rebuilt, suitable for irrigation or municipal waterworks.

ALSO 26,000 feet new pipe 30 inch O.D. 5/16 inch wall, 35-45 foot lengths.

GENERAL MACHINERY LIMITED
GRANVILLE ISLAND **VANCOUVER, B. C.**

HIGH PRESSURE TURBINE-GENERATORS

IMMEDIATELY AVAILABLE

1—12,500 KW 350# 600 Deg FTT, 13,800 V

1—10,000 KW at 70% P.F., 600 PSIG, 750 Deg. FTT, 12,000/13,200 V. Installed 1947.

1—2500 KW 80% P.F. 250/400# Aut. Ext. 50# Condensing, 3/60/13800.

1—3000 K.W. 400# Condensing, 3/60/2300/4160.

Complete with Surface Condensers and all Auxiliaries.

CHARLES WEAVER, INC.

19701 James Couzens Highway, Detroit 35, Michigan

Telephone: Broadway 3-1900

BOILER PLANT FOR SALE

Here Is Your Opportunity To Acquire Boiler Plant At A Very Reasonable Price

2—560 H.P. Erie City Self Contained Water Tube boilers, 160 lbs. with Canton Stokers. Can be moved without dismantling.

3—250 H.P. Titusville Firebox Boilers No. W.P. 250 125 lbs. pressure, 1944, 2500 sq. ft. Heating Surface.

2—200 H.P. Erie City Economic Boilers No. 152, 125 lbs. pressure, 1944, 2000 sq. ft. heating surface.

1—250 H.P. Erie City Economic Boiler No. 174, 150 lbs. pressure, 1944, 2641 sq. ft. heating surface.

— Condition Excellent —

All the above firebox boilers are equipped with Riley hydraulic stokers, Copes feed water regulators, non return valves, and injectors.
The above is a complete plant. Including complete coal elevator and conveyor system to each boiler, boiler water preheater, water treating system, flow pressure and draft gauge meters for each unit, all piping valves, etc.
Can be bought as a complete unit or individually. Several 150 H.P. 100 lbs. WP w/ stokers also available.

ABC DEMOLITION CORPORATION

1331 JEFFERSON DAVIS HWY.

ARLINGTON, VIRGINIA

OT 4-8755

2 OIL BURNING BABCOCK & WILCOX WATER TUBE BOILERS

Designed for T2-SE-A2

Now being removed at Philadelphia, Pa., from the S.S. Mission San Francisco.

Complete with deaerating feed heaters, Coffin feed pumps, oil pumps, 1st, 2nd & 3rd stage heaters. Evaporation: normal 43,000 lbs.; max. 60,000 lbs. Designed boiler pressure 700 P.S.I. Final steam temp. at superheater outlet 825° normal. Superheat safety valve setting 624 P.S.I. Boiler heating surface including water wall 6350 sq. ft. Total water heating surface 8030 sq. ft. Economizer heating surface 1680 sq. ft. Operating pressure superheater outlet 600 P.S.I. Furnace volume 573 cu ft. Evaporation rate from and at 212 F lbs/hr/sq ft of total boiler heating surface: Normal 8.33—max. 11.74. Water wall heating surface 118 sq ft. Feed water temp 240 F. Immediate delivery. Presently on barge at Philadelphia. Dimensions: 19'8" high over drum flange: 14' 9-5/16" over casing plate; 16' wide over drum.

THE BOSTON METALS CO.

313 E. BALTIMORE STREET

BALTIMORE 2, MD. CUrtis 7-5050

AIRCRAFT FOR SALE

PBY AMPHIBIAN AIRCRAFT

- Surplus to Canadian Exploration Company's use.
- Extra Large Cargo Door and Cargo Floor.
- Executive Passenger Compartment, Emergency Rocket Power.
- Galley Facilities, Survey Turret in Nose.
- Aircraft Completely Outfitted for Instrument Conditions and 2 Crew Operation, Extremely Well Maintained and in Excellent Condition.

Available for Immediate Sale at Reasonable Price

FS-7056 POWER

Class. Adv. Div., P.O. Box 12, N. Y. 36, N. Y.

COMPRESSORS

1902-1957

WORLD'S BEST REBUILTS

138 CFM 100 psi 7x7 Ing.—ESI
234 CFM 100 psi 9x9 Ing. ESI & Worth
268 CFM 500 psi 10—4¼x10 Ing. XOB
368 CFM 100 psi 12x10 IR-CP—Penn
389 CFM (actual) 100 psi Fuller C80-80H
420 CFM 40 psi 12x9 Ing. ES—Oil-Less
480 CFM 125 psi 12x13 Worth HB
465 CFM 100 psi 12x11 Penn 3AT & IR
503 CFM 220 psi 13½/7x13 IR—ES-2
528 CFM 100 psi 14x12 IR-CP—Penn
585 CFM 100 psi 15—9¼x12 IR—XRE 3-60-4160
590 CFM 100 psi 13½—8x8 Penn DE2
676 CFM 100 psi 15—9¼x12 Ing. XRB & XRE
686 CFM 100 psi 14x13 Worth HB
870 CFM 125 psi 17—10½x12 Ing. XRE 3-60-220
1007 CFM 100 psi 18—11x2 Chic. OCB
1060 CFM 60 psi—12-12x7 Chic YDE 3-60-4000
1410 CFM 35 psi 20x13 Worth—HB—UNUSED
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1—2250 HP Elliott 300 V. 200/300 RPM DC Motor with 2400 KW GE MG Set. 300 V. DC 2300/4600 V. 450 RPM 3 ph. 60 cy.
1—1375 H.P. G.E., MCF, 415 V. 1300 RPM D.C. motor with 1100 KW G.E. MG Set 415 V. DC, 2300/4000 V. 720 RPM 3 ph 60 cycle.
1—1200 HP G.E. MPC, 600 V. D.C. Motor, 450 RPM, and 1000 KW, G.E. M-G Set, 600 volt DC with 1400 KP, .8 PF, Synch. Motor 13200/6600 volt, 3 ph. 60 cy.

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-579BS	4800/2400	1800
1	1500	G.E.	MT	6900	1187
1	1100	F.M. BB	SF806S	4800/2400	1800
1	800	Whse.	CW	550	1776
1	750	G.E.	MT-573	2200	1190
1	700	Al. Ch.	D.P.	2300	500
1	600	Whse.	CW-432D-15	440	1778
1	500	Whse.	CW	550	350
1	350	Cr. Wh.	SIZE-718R	208/406	1765
1	350	G.E.	IM-17A	440/2200	720
1	350	Whse.	CW-1039C	C-15 440	720
1	250	G.E.	MT-424Y	4000	257
1	250	Cr. Wh.	SIZE-290	2300	350
1	250	A.C.		550	600
1	200	G.E.	IM	2200	580
2	200	G.E.	IM	2200	435
1	200	G.E.	MT-357Y	2200	1760
2	200	Whse.	CW-890	2300	1775

SQUIRREL CAGE

1	800	G.E.	KT-573	2200	1180
1	500	G.E.	FT-559AY	2300	3600
1	550	Whse.	CS-1115	2300	900
4	500	Whse.	CS-1216	2200	500
2	450	Whse.	CS-1420	2300/4150	354
2	400	Whse.	CS-7151-610H	6600/4000	3565
1	400	G.E.	IK	2200	500
2	200	G.E.	KT-557	440	1800
2	200/150	Whse.	CS-963H	2300	1175/875
1	200	Whse.	CS-1002	2300/440	450
1	150	Whse.	CS	440	580
1	150	G.E.	IK-15A	2300	860

SYNCHRONOUS

1	7000	G.E.	ATI	2240/6600	600
1	4350	C.W.	3501-SL	13800/6900	514
1	3500	G.E.	TS-6487P	4600/2300/4000	360
2	1750	G.E.	ATI	2300	3600
1	1750	G.E.	TS	2300	900

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2100/1750	G.E.	514	250/350	2300/4600
1	2000	G.E.	514	660	2300/4600
1	1500	G.E.	720	600	6600/13200
1	1000	G.E.	900	260	6600
2	1000	G.E.	720	600	6600/13200
1	750	G.E.	720	275	6600/13200
1	750	G.E.	720	125/250	2300/4600
1	500	Whse.	900	125/250	440
1	350	G.E.	900	125	440/2300/4160
2	300	G.E.	1200	250	2300
1	250	Whse.	1200	275	2300
1	200	El Mby	1200	250	2300/4600
1	300	Whse.	1200	600	2300
1	200	Whse.		550	2300
1	200	G.E.	1200	250	550/2300
1	200	Cr. Wh.	1200	250	440
1	150	Whse.	1200	275	2300
1	100	G.E.	1200	250	4160/2400

TRANSFORMERS

Qu.	KVA	Make	Type	PH.	Voltages
3	3333	Whse.	OISC	1	13800x2300
1	1500	G.E.	PYRANOL	3	auto 4000/4200/4400
3	1000	G.E.	OISC	1	13800x460
2	750	G.E.	FUR	1	4800x265/55
3	500	KUHL	OISC	1	13800x6000
1	225	Marcus	Air	3	auto 208/320
3	100	G.E.	OISC	1	22900x2400/4160Y
3	100	Whse.	OISC	1	4600x460/230/115

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltage
1	5000	G.E.	60/50/60	660/11000/6600
2	2500	G.E.	25 cy/62.5	2300/2300
1	500	Al. Ch.	25/60	11000/2300
1	200	G.E.	60/3000	440/880

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	10000	Whse.	Condensing 650 lbs. 750° F.T.T. Surface Condenser Dir. Conn. Exciter.
2	3375	G.E.	650 lbs., 725° FTF, 150 lbs. G.B.P. non-condensing
1	2000	Al. Ch.	175 lbs., 5/30 lbs. G.B.P., non-condensing 3/60/480 volts.

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REBUILT

HP	Make	Type	Speed
400	West. B.B. Drip.	CSP-681S	1800
400	West. S.B. Open	CS	900
350	A.C. S.S. Drip	ARWW-626	3600
300	G.E. S.B. Open	IK	1800
300	A.C. S.B. Open	AR-630	1800
300	G.E. S.B. Open	IK	900
300	G.E. S.B. Open	IK	720
300	West. S.B. Open		

SQUIRREL CAGE MOTORS NEW AND GUARANTEED

250	G.E. TEBB, 2300 V	CS-1002 K	600 1800
250	G.E. S.B. Open	KT	1800
250	F.M. B.B. Open	H	1800
250	L.A. B.B. Drip	OGX	1800
250	G.E. S.B. Open 2200 v	IK-16	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. S.B. Drip	K-6326	3600
200	F.M. B.B. Open	H-207	1800
200	G.E. TEBB	K	1800
200	A.C. S.B. Open	ARW-626	1800
200	G.E. S.B. Open	AT-558	1800
200	Cont. T.E.F.C. B.B.		1800
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-15S	1200
200	G.E. S.B. Open	KT-562	1200
200	G.E. S.B. Open 2200V	IK	1200
200	L.A. T.E.F.C. B.B.	JX-137	1200
200	G.E. S.B. Open	IK	900
150	G.E. TEFCBB	K-6328	3600
150	G.E. TEFCB XP	K	3600
150	L.A. B.B. Open	OGX-107	1800
150	G.E. TEBB	K	1800
150	West S.B. Open 2200V	CS	1800
150	G.E. S.B. Open	IK	1800
150	West. S.S.B. 2200V Open	CS-772C	1200
150	G.E. S.B. Open	KT-558	900
150	Cont. T.E.F.C B.B. New		900
150	G.E. B.B. Open	KT-558	900
150	G.E. S.B. Open	IK	720
125	G.E. TEFCBB	K	3600
125	West. S.S.B. Open New	CS-607	1800
125	G.E. S.B. Drip	K-505	1800
125	G.E. S.B. Open	IK	1800
125	West. S.S.B. Open	CS-716C	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	G.E. S.B. Open	IK	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	A.C. B.B. Open	AR-423	3600
100	A.C. S.B. Open	AR-505S	3600
100	Reliance B.B. Open	AA-504	3600
100	G.E. S.B. Open	KT-343	1800
100	A.C. S.B. Open 2200 V	ARX	1800
100	G.E. S.B. Open	KT-347	1200
100	West. SSB Open	CS-607	1200
100	West. SSB Open	CS	1200
100	A.C. SB Open 2200 Volt	ARX	1800
100	G.E. S.B. Open	IK	900
100	Howell B.B. Open	NC-684	900
100	G.E. S.B. Open	KT-356	900
100	G.E. S.B. Open	IK	720
75	West. T.E.F.C. B.B.	New CS-7546	1200

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SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	440	Whse.	514
400(2)	2300	G.E.	900
400	4000/2300	Whse.	720
350	4000/2300	G.E.	720
300	2200	G.E.	450
300	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	220/440	Whse.	720
125	2300	G.E.	600
100	440/220	G.E.	720

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G.E.	ATI	720
375	2200	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G.E.	TS	720
300	2200/440	G.E.	TS	1200
150	440/220	G.E.	TS	720
125	440/220	Whse.	HR	400

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
500	2200/4000	Elliott	SC	1800
350	2300/440	G.E.	IE-K	1200
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
250	440/220	G.E.	KT	720
200	440/220	G.E.	KT	1800
200	2300	G.E.	KT	1800
200	440/220	G.E.	KT	720
200	2200/440	G.E.	IE-K	1200
150	440	Whse.	X-prf.	3600
150	2200	Al. Chal.	AR	1800
150	440/220	G.E.	KT	720
150	2200/440		KT	600
150	2200/440	G.E.	FT	1200
125(2)	2300/440	Whse.	X-proof	720
125	2300/440	G.E.	K	600
100(2)	4000/2300	L. Allis	OX	1200
75	2300/440	Whse.	TEFC	1200

A. C. GENERATORS

1—320 kva, 660 rpm, 2300/440/220 V., G.E.
1—360 kva, 900 rpm, 2300 V., Whse.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

9—1600 amp ITE, 3 pole, 600 V.
6—FKB-155-28, 600 amp., 15,000 V. G.E.
1—400 Amp., Condit. 3P, 25 KV outdoor
1—400 Amp. B. Smith, 3 P 7.5 KV outdoor

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
235	230	Whse.	SK	1800
200	230	Cr. Wh.	CMC	1200
150	230	El. Dyn.	B/brg.	600
125	230	G.E.	CD	850

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440	Syn.	250
125	G.E.	440/230	Sq. Ca.	125
125	G.E.	440	Sq. Ca.	250/125
100	G.E.	2200/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	240/120
65	G.E.	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al. Ch., 2400/4160Y—600 volts, 3 ph
3—500 kva, G.E., 13,600—300 V.
3—333 kva, G.E., 13,800—2300 V.
2—300 kva, G.E., 4150—240 V., 3 ph., Pyr.
1—200 kva, Al. Ch., 6900—220 V., 3 ph.
3—200 kva, Whse., 4600/2300—230/115 V.
1—200 kva, G.E., 2400—120/240 V., Pyr.
3—200 kva, Mol., 13,800—2300 V.
3—150 kva, Al. Ch. 2400—220 V.
3—150 kva, Al. Ch. 440-220 V., dry New
3—150 kva, G.E., 13,200—2300 V.
3—100 kva, G.E. 2400—120/240 V., Pyr.
6— 50 kva, G.E., 13800—120/240 V.

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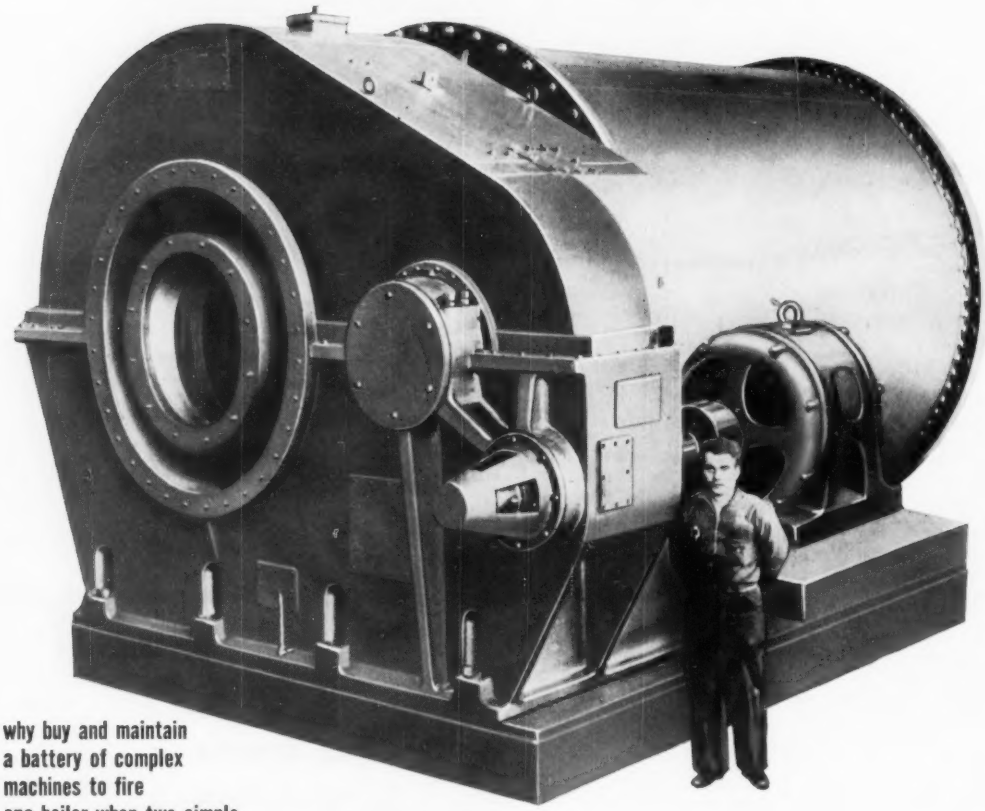

why buy and maintain a battery of complex machines to fire one boiler when two simple

KENNEDY AIR SWEPT BALL MILLS will do a better job

When you buy a KENNEDY Pulverized Coal Firing System for your power plant, you save on first cost, maintenance, space and equipment.

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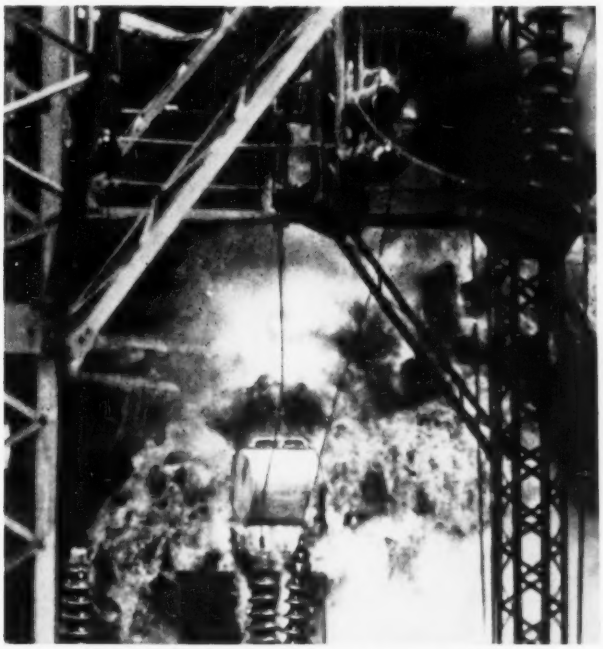
Transformer Fires!



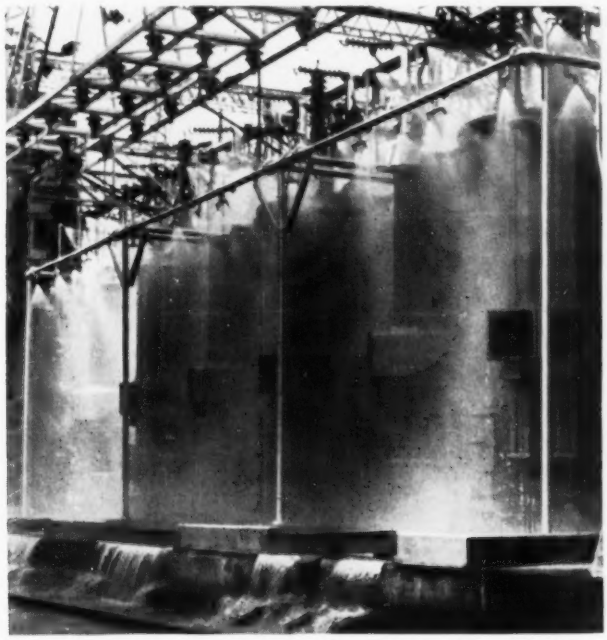
Transformer fire at this power station caused an estimated $50,000 damage. There was no special fire protection system on guard.

When fire occurs, you can depend on GRINNELL MULSIFYRE to extinguish it... fast

A Grinnell Mulsifyre System is effective wherever the danger of fire in medium or heavy oils can be limited to a definite area. Grinnell Mulsifyre Spray Projectors usually have the fire *completely* out in a matter of seconds after the water discharge starts.

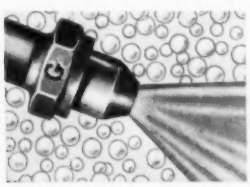
Three recent transformer fires which prove the ability of Grinnell Mulsifyre to put out oil fires quickly.

- Considerable oil was spilled when there was a failure in a 100,000 KVA transformer. The flash fire which resulted was immediately extinguished by the automatic operation of a Grinnell Mulsifyre System. This fire, if not checked, could have destroyed transformer, an adjacent transformer of equal capacity, and associated bus structure.
- In another utility fire, the cause originated with a faulty H. T. bushing on a 50,000 KVA transformer. A break in the bushing sprayed burning oil over the surrounding equipment. The heat-activated Mulsifyre System took only 20 to 30 seconds to extinguish fire on the bank.
- Bushing failure resulted in still another fire in a 150,000 KVA transformer. This transformer was protected by a manually controlled Mulsifyre System. Fire was rapidly extinguished upon manual operation of system except for blaze at the top of the bushing which was above the space protected by the Mulsifyre system. Fire damage to transformer was limited to fan blades and blistered paint on radiators.



Transformers at this power station are safeguarded by a Grinnell Mulsifyre System. Mulsifyre's fast, automatic spray action is being demonstrated.

For detailed information, write . . . Grinnell Company, Inc., 277 West Exchange Street, Providence, R. I. Branch offices in principal cities.



GRINNELL *Mulsifyre*

EMULSION EXTINGUISHMENT OF OIL FIRES

Top gauge shows steam pressure of 4500 pounds per sq. in. for turbine No. 6 at the Philo plant of Ohio Power Co., an operating company of American Gas and Electric Company.

New "super-pressure" steam unit requires ultra-pure water

• The higher its temperature and pressure, the more work steam will do for each pound of fuel you use. That's why power-plant steam pressures have been steadily climbing. First "super-critical pressure" unit is No. 6 in the A. G. & E. System's Philo Station. It operates at the tremendous pressure of 4500 psi (almost double previous "highs") and at a new high temperature of 1150°F.

At this pressure, it requires pumps with giant 5000 hp motors, each with the power of 2 freight locomotives, just to force water into the "boiler." In fact, the water doesn't even boil or bubble; it just flashes over to an invisible gas. And at 1150°F, the steam is hot enough to melt aluminum. Steam pipes to the turbine actually glow red under their insulation!

At Philo it is especially important to treat feedwater to remove dissolved solids that form scale and cause expensive damage. Unlike ordinary boilers, Philo's No. 6 has no drum in which dissolved solids can be concentrated and blown off. *All* the feedwater is flashed to steam . . . *any* solids would deposit in the boiler tubes or turbine.

To prevent these problems, the water for No. 6 unit is treated with a Permutit Demineralizer that reduces solids content to an average of 1/10 part per million!

You may not need water 99.99999% pure for your power, process or service requirements, but Permutit experience can help you find the right treatment for your job at the right price. Write for details to The Permutit Company, Dept. P-2, 50 West 44th Street, New York 36, or Permutit Company of Canada, Ltd., Toronto 1, Ontario.

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